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Failure of a Retaining Wall at the Kingshighway Viaduct, St. Louis, Mo.

The approach to the new reinforced-concrete viaduct carrying Kingshighway Boulevard across a shallow valley at St. Louis, Mo., suffered a mishap on June 30, a part of one of the retaining walls being thrown down by internal pressure. This structure was fully described and illustrated in ENGINEERING NEWS of June 27. As there shown, a part of the approaches consists of an earth fill between concrete retaining walls. Where these retaining walls exceeded 11 ft. in height, they were made hollow and the interior was filled with earth, mainly clay. The front and back walls were tied together by cross-walls at intervals of 18 ft. 2 in., where the total height of the wall did not exceed 17 ft., and at intervals of 21 ft. 5 in. for the higher portions. When the wall was completed, the interior earth filling was to be covered with paving to protect it from saturation and under-drains were provided to carry off any percolating water.

The filling between the walls had been nearly completed, when a hard rain storm saturated the unprotected earth filling so that the wall was subjected to a heavy bursting pressure and the outer face of the wall fell. The failure extended for a length of about 60 ft., covering one of the nine panels of the filled approach; this was the last panel, adjacent to the abutment of the first group of arches. The character of the accident is shown very clearly in Fig. 1, while Fig. 2 shows the construction of the wall. Each retaining wall confining the filled part of the approach consisted of two parallel walls 3 ft. apart, standing on a base 7½ ft. wide and connected by 12-in. cross-walls about 20 ft. apart. The thickness was 12 in. for the inner and 15 in. for the outer wall, the latter being increased to 18 in. for 6 ft. above the base course.

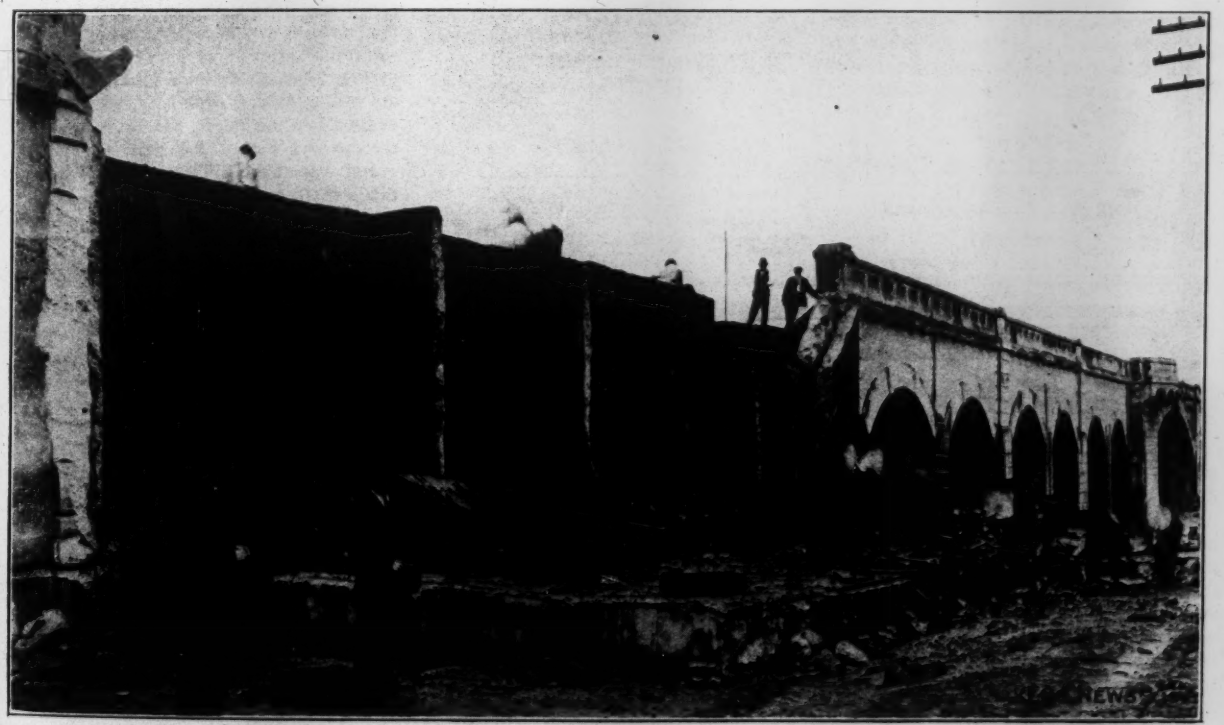

FIG. 1. FAILURE OF A CELLULAR RETAINING WALL ON THE APPROACH OF THE KINGSHIGHWAY VIADUCT; ST. LOUIS, MO.

At the time of the accident the filling of the approach had been under way for 11 months. The filling material was mainly clay. The street level had been attained from the north entrance, south as far as the approach terminal pier or abutment pier, and from the main arches north to the same point. At this middle point two considerable depressions had been left (one on each side of the viaduct) which were to be filled subsequently with such surplus earth as might remain after dressing up the main fill. At about the point of these depressions were located the drains which were to take care of the surface water from the finished roadway. These drains had been stopped, however, by the filling and were in that condition at the close of work on the Saturday previous to the failure.

The following day, June 30 (Sunday), an extremely severe rain storm occurred, the precipitation amounting to 2.98 in. in three hours. The drainage from the section of the approach south of the depression mentioned above worked down to these depressions, filling them to at

least their full depth. The drainage area amounted to 18,000 sq.ft. At the point where the retaining wall ends at the approach terminal pier there is no expansion joint. The rear wall extends 6 in. into the cross-wall of this pier, the front wall being continuous with the face wall of the pier. The buttress or bulkhead closing the west retaining wall at the junction of this wall with the abutment pier had been omitted above the level of the tool room situated in this pier (as shown in the elevation in Fig. 2), there being no necessity for such construction at this point. The water impounded in the two depressions mentioned above could readily percolate through the loose filling into the space between the front and back walls to the opening formed by the omission of this bulkhead.

The cells of the retaining walls had been filled with clay some seven months previous, and this filling undoubtedly had had an opportunity to dry and shrink. This allowed the water from the depressions to gain access to the cells immediately adjacent to the terminal pier, and to set up a hydrostatic pressure; the drains which had been placed to keep the filling dry were either inadequate to discharge the volume of water or else became clogged. Assuming that hydrostatic pressure was developed in the cell adjacent to the terminal pier and for the full height of the wall, it has been calculated that the overturning moment about the foot of the wall for the length of a cell was upward of 2,270,000 ft.-lb. The only reinforcement tying the front and back walls together consisted of ½-in. round bars embedded in the cross-walls and spaced 2 ft. apart vertically. This was, of course, inadequate to resist a force of the above magnitude.

That the retaining walls were adequate for the service for which they were designed is considered by the engineers to be proved by the fact that the back wall by itself retained the pressure of the saturated filling in the roadway, even when the failure of the front wall left the back wall unsupported. The photograph, Fig. 1, shows that one of the cross-walls went down with the front wall, and in its failure exerted a heavy pull on the back wall, yet this back wall remained in place, although only some 18 in. thick, and unsupported for a length of 34 ft.

The wall that fell has been repaired by a solid filling of concrete from the back wall to the finished surface.

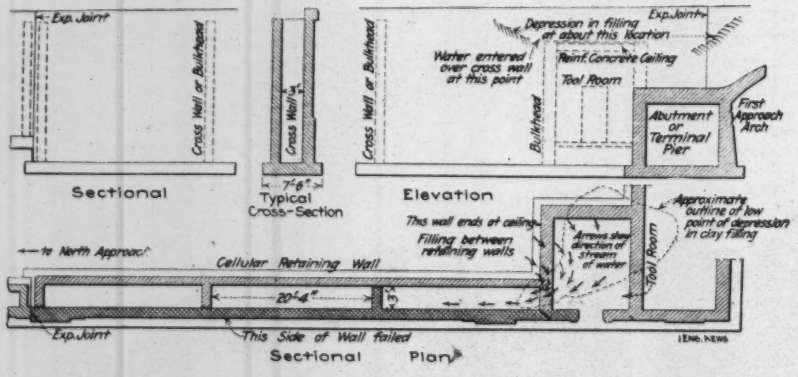

FIG. 2. DETAILS OF CONSTRUCTION OF CELLULAR RETAINING WALL OF KINGSHIGHWAY VIADUCT, SHOWING PORTION WHERE FAILURE OCCURRED

Concrete Pavements; Their Advantages and Disadvantages

BY P. E. GREEN*

During the past two or three years, many descriptions of concrete pavements laid in various parts of the country have been published and considerable enthusiasm for this class of construction as a pavement on streets having a light to moderate traffic has been manifested by city engineers. It is believed by the writer that there are some grave defects in concrete pavement, which, as far as our present knowledge of the material is concerned, restricts its use to rather narrow limits.

There are two characteristics of concrete which tend to reduce its value as a pavement: susceptibility to changes in temperature and inability to resist abrasion. The coefficient of expansion is high, being about 0.000006, and to make the case more difficult, this expansion often takes several weeks to fully manifest itself. Every one has seen this action in the case of concrete sidewalks (Fig. 1). Curbs are frequently sheared off in this way, and an ordinary sidewalk will expand 6 in. in a block of 300 ft., partly the result of temperature and partly of chemical activity while setting up.

It has been stated that the largest part of this expansion is due to moisture, and that if moisture is excluded, the expansion will be almost entirely eliminated. The writer is inclined to question this, for while moisture may accelerate the expansion, it is not believed that it really affects the ultimate condition.

If the concrete foundation of any pavement laid in the summer and exposed for two or three days to the hot sun be examined, cracks will be found at intervals of 10 to 20 ft. extending across the roadway. They are especially noticeable after the cool of the night, during which time contraction takes place. It is probable that two out of three asphaltic pavements having a concrete base show cracks during the winter extending across the roadway at intervals of 50 ft. or so, and examination will show that in nearly all cases the cause is the foundation.

In the past too little attention has been given to this problem. Concrete pavements as laid have been provided with expansion joints transversely at intervals of 100 ft., and sometimes longitudinally along the curb. This amount of expansion joint is entirely inadequate and the result has been that within a short time the surface has become a mass of unsightly cracks. This is well illustrated by Fig. 2, which shows a street of moderate traffic, having expansion joints about every 60 ft. and along the curbs. It was three years old at the time the photograph was taken. The writer witnessed this construction. It was a two-course job, granite top, and very carefully done.

In this connection, it is not amiss to call attention to the effect of the appearance of unsightly cracks upon the value of adjacent property in city streets. Property owners for this very reason have frequently bitterly fought asphalt pavements, many of which in the early years of that industry became badly cracked in a few months after they were finished. It has been suggested by some well known engineers that the cracks in concrete pavements are not of great importance, and if desired, they may be cleaned out and filled with bitumen. This may be all right for country roads, but it certainly would not do for city streets, where the appearance of the pavements has a very decided effect upon the value of the property.

The second important characteristic of concrete, that of inability to resist abrasion, is also very vital, though it may in a measure be controlled by the selection of the stone to be used in the wearing course. The writer is convinced that for such a purpose a very hard, dense stone is required, such as granite or trap rock, and if such stone is not available a very moderate amount of traffic will soon ruin the pavement. Even with the use of granite, and under a moderate city traffic, in two or three years the wear is very apparent.

Recently a news item was published in

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a technical paper to the effect that some Minnesota officials had inspected Chicago concrete pavements and had been highly pleased with them. The writer does not know how the inspection was made, but thinks it rather strange in view of the fact that, as a street pavement, concrete has not been a success in Chicago except possibly in alleys. In spite of careful construction, nearly all of it has become badly cracked, and where there has been heavy teaming traffic, the maintenance has been very expensive.

Repairs to a concrete pavement are not easily or cheaply made, in spite of assertions to the contrary. It will not do to make a repair by plastering. The section must be cut out completely and a new one put in, and good workmanship is required to get adequate results.

The technical journals of the country have discussed for years the best method of joining old and new concrete. Such discussion is the best possible evidence that to make a satisfactory bond is not an easy operation, yet it is often asserted that it is a simple matter to make repairs to concrete pavements. Such a statement is misleading.

Concrete lacks a fundamental quality without which it is believed no pavement can be a success; that is, elasticity. In the general theory of pavements some means of sustaining a load and of transmitting the shock of impact to the foundation must be provided. This is done in most of the modern types of construction by dividing the pavement into two separate and distinct parts—the foundation and the wearing surface. The foundation maintains the load and the wearing surface transmits the shock of traffic to the foundations. A brick pavement, for instance, is usually composed of either a concrete or a well compacted macadam base, over which sand is placed to form a cushion upon which the brick or wearing surface is laid. The function of the brick is to withstand the action of traffic, both through impact and abrasion. The sand is a medium through which the shock is transmitted to the base which really maintains the load.

Concrete has not the power to resist either abrasion or impact to so great an extent as brick, and is thus less fitted for a wearing surface. If such a pavement, for instance, were made in two courses with some such material as sand between these courses, the lower course or base might possibly be preserved indefinitely, but the upper course would in all probability wear too rapidly to compare economically with any of the other styles of pavement in the same class as regards first cost and maintenance.

There has been recently a considerable advocacy of covering the rough surface of a concrete pavement with a mixture of bitumen and sand, the bitumen being generally tar. The cost of this treatment is not high, running from 10 to 20c. per sq.yd. At first sight this would appear to be a good idea, but experience with bituminous macadam and sheet asphalt tends to make the writer

FIG. 1. VIEW SHOWING EXPANSION OF CONCRETE SIDEWALK, HAMILTON, AVE. AND CONGRESS ST., CHICAGO, ILL.

(Reproduced from Engineering News, Oct. 7, 1909, p. 379.)

believe that it should be accepted with caution.

In the first place both tar and asphalt are very susceptible to changes in temperature, and tar especially so. Also tar having a high melting point is largely pitch, and at low temperatures is very brittle. Hence, if there is even a moderate amount of traffic on the pavement in cold weather, it will tend to spall off in large patches if the concrete is at all smooth, giving the pavement an unsightly appearance. If a tar having a lower melting point is used, the result will be bad in hot weather, the surface becoming soft and sticky. If a blown oil asphalt be used instead of tar the result would probably be still worse, as such asphalt has not great binding qualities and the scaling under traffic during winter would be even more noticeable, though in summer the asphalt would not be so affected by the high temperature. It would seem, therefore, as if on high-class residence streets, which receive a daily cleaning, that the use of this method is questionable.

In any case, in order to keep such a pavement in good condition, under a moderate traffic (for example, of 150 vehicles per 24 hours) it would be necessary to resurface with bitumen at least once in two years, and probably once a year, and if the average cost per square yard be taken at 15c., it will be seen that there is a decidedly high annual maintenance charge against this pavement. An economic comparison with a block or an asphalt pavement will show that it would be much better to put in the more expensive product.

To sum up, the advantages of concrete pavement are:

(1) Cheap first cost,
(2) Dustless and sanitary,
(3) Good appearance if no cracks appear,
(4) Easily cleansed.

Its disadvantages are:

(1) Liability of cracking,

FIG. 2. CONCRETE PAVEMENT IN CHICAGO
(Ohio St. Near St. Clair St.)

(2) Inability to withstand abrasive action,
(3) Bad appearance if cracked,
(4) If covered with bitumen, high maintenance charges.

Weighing these advantages and disadvantages, a proper location for such a pavement can be selected.

(1) In alleys. Here the traffic is generally light, appearance not so important as in the street and the arched form of the pavement makes it present its line of greatest resistance to temperature stresses.

(2) In streets of light traffic (less than 100 vehicles per day) in climates having small variations in temperature, such for example as New Orleans, Los Angeles, San Francisco, Portland, Seattle.

(3) In inclosed areas such as warehouse floors, etc., over which considerable teaming is done, but which do not suffer from extreme ranges of temperature and in which the traffic is very slow moving.

(4) Country roads where the value of the property would not be affected by cracking, etc., and on which 250 vehicles per day would be considered a heavy traffic. Its resistance to the abrasion produced by automobiles is high, and it can take a large amount of such traffic. The State of Ohio has made some valuable experiments along this line.

(5) City streets having such steep grades that practically no teaming can be done, and where the property, though not valuable, desires to have some form of cheap pavement. As an example, Kansas City, where many of the streets have very steep grades.

Improper locations for concrete pavements would seem to be:

(1) Streets of more than a very moderate traffic, that is greater than about 200 vehicles per day.

(2) Streets in climates having great variations in temperature, such as Chicago, Gary, Indiana; Cincinnati, St. Louis, etc. In such climate it is necessary to place expansion joints very close together, and every expansion joint is a line of weakness, and a place where rapid abrasive action will become very evident.

Concrete is a valuable and useful material, but it has not yet been demonstrated by time and use, that it is a good city street pavement. A pavement, to be considered a permanent one, should be able to give at least 10 years' satisfactory service under a moderately heavy traffic, during which time the cost of repair should not exceed one-half the original cost of the pavement. It would seem, therefore, as if much money might be saved to cities contemplating the use of concrete pavements if they would follow the practice of the French engineers and refuse to lay any considerable yardage of pavement until time and traffic had approved its usage.

Street Railway Track Reconstruction at Vancouver, B. C.

By C. B. Vorce*

Track reconstruction has been carried out recently over a part of Granville St., Vancouver, which is a principal business street with tracks used by six car lines and over which pass about 150 cars per hour. The tracks on Granville St., between Robson and Drake St., a distance of half a mile, were causing the cars to ride so badly that reconstruction was imperative. It was not advisable to rebuild during operation, and as there is a double-track line only two blocks away, the Board of Public Works granted the British Columbia Electric Ry. permission to abandon traffic during construction, providing it was restored in 24 days.

The street was paved with wood blocks laid on 6 in. of concrete, and each rail of the double track was carried on a concrete girder 24 in. wide and 15 in. deep. Owing to the nature of the foundation these girders were not heavy enough to sustain the weight imposed upon them, and on this account the company adopted for the new work the type of construction shown in Fig. 1. This construction consists of a 6-in. concrete slab which is laid over the entire track allowance, 18½ ft. wide; upon this are ties 6x8 in., 8 ft. long, spaced 2 ft. centers and carrying 91-lb. T-rails 7 in. high. The rails are laid with broken joints. Tie-rods are placed 24 in. on each side of the joint and between these are tie-rods, equally spaced, making a total of ten rods to each rail length. The track is then surfaced to grade on a sand cushion averaging 1 in. deep, and the concrete is brought up to the under side of the pavement by means of a traveling concrete mixer on each track. From the standard cross-section in Fig. 1, it will be seen that the bottom of the concrete slab is 20 in. below the rail grade.

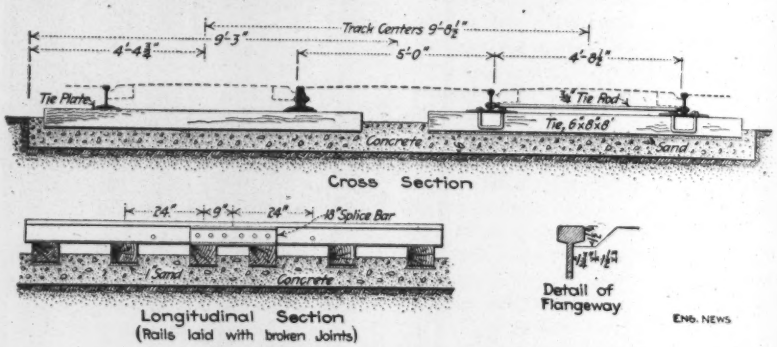

Fig. 1. Standard Track Construction of the British Columbia Electric Railway Co.; Vancouver, B. C.

The reconstruction of the tracks called for taking out and replacing the following quantities: 5100 sq.yd. of wood-block paving; 10,200 lin.ft. of rail or 5100 lin.ft. of single track; 1800 cu.yd. or 5100 sq.yd. of concrete; 600 cu.yd. of earth; and the laying of 2400 cu.yd. of concrete; half a mile of double track; 850 sq.yd. of granite flangeway blocks, and 4250 sq.yd. of wood blocks.

The concrete had to be allowed to set for ten days before traffic could be turned back on the street. This necessitated the completion of the work above outlined, except the paving, in 12 days (and not 14 days, as two Sundays intervened). The work was carried on day and night, and a schedule was prepared showing the rate of progress which must be made on each of the operations in order that the work should be completed within the time limit. This schedule was so closely followed that all work, except the paving, was finished one hour before the time called for by the schedule, and during the ten days the concrete was setting the street was repaved, so that

*Engineer of Construction, British Columbia Electric Ry. Co., Vancouver, B. C.

Fig. 2. Concrete Breaker and Derrick Car Used in Breaking Up an Old Street-Railway Track at Vancouver, B. C.

when traffic was restored all the work was completed. This schedule is shown in Fig. 3.

The electric-railway company has a large construction force which does the greater portion of the required work, so it was sure of the speed with which the various operations (with the exception of breaking up the concrete) could be accomplished. The company had just built a piece of new track which called for the removal of about 300 sq.yd. of concrete of a similar nature, which had been laid by the same contractors. The stretch of concrete was removed by hand and it took 15 men six days to do the work. As the schedule for the work on Granville St. called for the removal of about 32 sq.yd. of concrete per hour, it was seen that some mechanical means must be used, and the following scheme was adopted:

The dipper arm was taken off the electrically driven Thew automatic shovel owned by the company, and pile-driver leads about 20 ft. long were hung from the end of the boom, being held in position by two braces running back to the main frame of the shovel. A hammer weighing 2600 lb. was specially cast, having a wedge-shaped cutting edge about 8 in. deep running parallel to the track. The cutting edge was placed this way in order not to injure the remaining concrete in the street. This scheme worked excellently and no trouble whatever was found in breaking up the concrete as rapidly as it could be taken away.*

The concrete breaker (which could swing through 360°) was placed on one track. On the other track was a derrick car having a 60-ft. boom, and this also could swing through 360° and could move itself along the track. This car was used to break up the larger pieces of concrete and to load them on flat cars placed behind the concrete breaker; also to unload skips in which were placed the smaller pieces of concrete and earth, this material being dumped into wagons standing alongside the track. The concrete breaker and derrick car backed up on the old track as soon as the concrete was broken up for a rail length ahead of them. Fig. 2 shows the two machines on the work, with the derrick car handling a skip.

The price of common labor was $3 per day of 10 hours; teams received $8 per day shift of 10 hours and $9.50 for the night shift. The average haul for teams was ¼ mile and for the track cars about two miles. The cost of the work was as follows: digging up wood blocks, 8.9c. per sq.yd.; tearing up old track, 11c. per ft. of single track; breaking up concrete, 40c. per sq.yd., or $1.13 per cu.yd.; excavation, loading and dumping, 82½c. per cu.yd.; removing material by teams and work train, 65c. per cu.yd.

G. R. G. Conway, M. Am. Soc. C. E., is Chief Engineer of the British Columbia Electric Ry. The work was carried on under the supervision of C. B. Vorce, M. Am. Soc. C. E., Engineer of Construction, assisted by H. J. Tippet, Engineer Maintenance of Way, and A. J. Kennedy, Roadmaster.

*A somewhat similar method of breaking up the conduit and track of an old cable railway at San Francisco was described in our issue of July 25. In that case, however, the hammer leads were inclined and a plain hammer was found more effective than one having a chisel face.—Editor.

An Exhaust Gas Turbine for utilizing the exhaust from reciprocating internal combustion engines, has been invented and is being perfected by Mr. Montague Churchill-Shann, of Sheen road, Richmond, England. Its most interesting feature is the method of construction which is employed to take care of the fact that the impulses delivered to the turbine are explosive and intermittent instead of a steady constant pressure such as is found in a steam turbine. Tests of this turbine, connected to the exhaust of a gasoline motor, seem to indicate an efficiency of the combination, somewhat higher than that of the motor alone. In the London "Engineer," issue of Aug. 23, a lengthy description of the turbine is given.

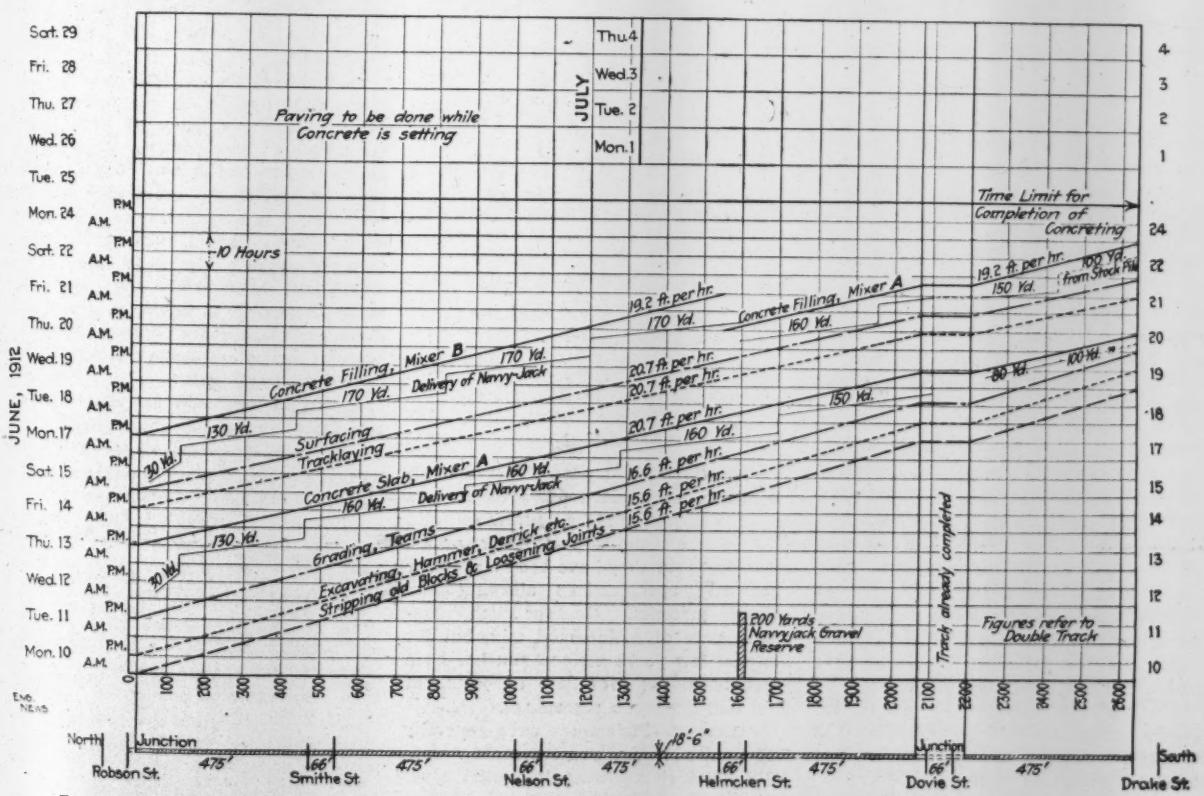

FIG. 3. PROGRESS CHART FOR TRACK RECONSTRUCTION; PREPARED IN ADVANCE TO ENSURE THE COMPLETION OF THE WORK WITHIN A SPECIFIED TIME

(Horizontal spaces from June 10 to 24 are ten-hour shifts.)

Life and Cost of Asphalt Pavements

By G. H. Norton*

The author has analyzed the cost and service records of sheet-asphalt pavements in Buffalo, N. Y., to find (1) a general average cost and probable life for comparison with figures for asphalt in other cities and figures for other kinds of pavements; (2) a probable cost, probable life, and economic life of sheet asphalt under different conditions of use.

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The city of Buffalo, N. Y., has had 33 years' experience with sheet-asphalt pavements; from the records of this long period the writer has made a study of probable durability and maintenance. For a proper understanding of the data, a few introductory notes are given, the figures being in round numbers and generally to June 30, 1911.

Construction

Amounts—Sheet asphalt was first laid in 1878, and more or less has been laid every year since. A large amount (2,700,000 yd.) was laid in the years 1889 to 1894 during a real estate boom, which forced improvements some years in advance of legitimate requirements. The total amount laid is 5,200,000 sq.yd., exclusive of that laid by the Park Board, not here included. The amount remaining is 3,880,000 sq.yd. under guarantee or city maintenance. Fig. 1 shows the amount laid each year and the amount remaining; Fig. 2 shows totals laid, remaining, under guaranty, and maintained by city for each year. The causes of removal are (1) deterioration requiring repaving, (2) taken over by the traction company when tracks were laid in streets, (3) by grade-crossing elimination works, (4) transfer to the Park Department, etc.

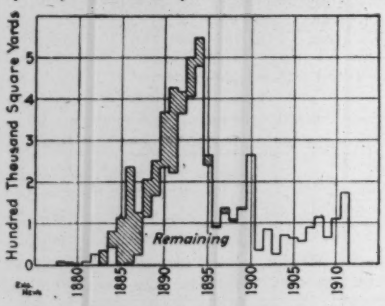


Fig. 1. Sheet Asphalt Laid Each Year in Buffalo, N. Y., and Yardage of Such Remaining July 1, 1911

Base, Grades, Etc.—Most of this asphalt was laid on a 6-in. concrete base. Natural cement was used for this base until 1903, since which time portland-cement concrete has been used. A few pavements are laid on macadam base. Since 1893 a considerable amount has been laid over common Medina sandstone pavement on a sand base. This has been satisfactory on residence streets of light traffic, but not for heavy traffic.

Much of this pavement is laid on flat grades, about one-half on grades of 0.33 to 0.40%. Asphalt has been seldom laid here on grades exceeding 3%.

Since 1891 drain tile has been generally used under curbs excepting those with a macadam base or where natural drainage was exceptionally good.

Most of the early pavements were laid with a ½-in. "cushion" coat; since 1892 1½ in. of open binder have been used. The top course has usually been 2 in. in thickness. There are slight exceptions—in some streets laid under private contract, in the "Abbott" pavements, and with some of the European rock asphalts.

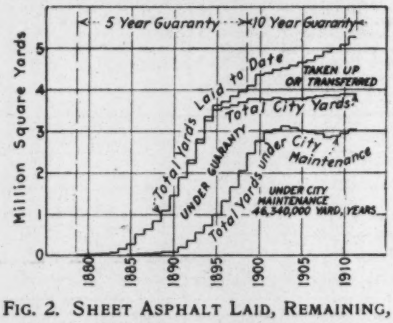


Fig. 2. Sheet Asphalt Laid, Remaining, Under Guaranty, and Maintained by the City of Buffalo in Various Years

The proportions of various kinds of asphalt are approximately:

Trinidad	83%
European rock	3%
Kentucky natural rock	4%
Bermudez	4%
Alcatraz	4%
Miscellaneous	2%

Specifications—Up to 1892, asphalt pavements were laid under specifications as to wearing surface, furnished and filed by the various paving companies. Since that year they have been laid under open city specifications allowing any suitable material. Most of such pavements were of a fine-sand mix, but for the past few years a stone mix has been much used, not over 25% of ⅜-in., or less, flint-limestone screenings.

Guaranty—Pavements were generally laid under a five-year guaranty until 1898, although a few of the earlier pavements had a six- or eight-year guaranty. Since 1898, all pavements have been laid under a ten-year guaranty. While there may be many reasonable objections to this long term, public sentiment has favored it and any change will only be possible after a campaign of education.

Traffic—The amount of traffic at five points was found to vary from 571 to 3480 vehicles (average 2511) for a 11-hr. day, giving an hourly tonnage of from 62 to 291 (average 203) and a daily tonnage per foot width of from 24.2 to 99.3 (average 60.2). The heavier traffic is a fair average for the most used streets and the lighter for medium outlying streets; many short residence streets have even less. Local observation does not confirm a common assumption that the life of an asphalt pavement is proportional to its traffic. It rather indicates that a moderate and distributed traffic is beneficial.

Life and Repairs

To determine the probable life of this pavement a study was made of that laid in 1891 or previous to that year—about 1,900,000 yd., of which amount there remained in use July 1, 1911, over 850,000 yd., or 45%, although large transfers had been made by car-track construction. The average age of this remaining pavement and of all that which had been removed for deterioration is 19.57 years, that for streets without car tracks being 20.68 years, and for streets with car tracks 17.95 years.

To arrive at the probable average life of all these pavements it is necessary to add to the above figure of 19.57 years the effect of the probable duration of the pavements yet in use. While impossible to predict the expectation of life for them, it is assumed at an average of three years. Should such be the case, then the average life of all these pavements laid in or before 1891 would be about 21 years. It should be noted that these were laid under contractor's specifications, on natural-cement concrete, and largely over clay soil.

It may be said that the above figures are deceptive in that they extend from

TABLE NO. I. ASPHALT PAVEMENTS REPLACED BECAUSE OF DETERIORATION. BUFFALO, N. Y.

Year Removed	Yards in Streets Without Tracks	Yards in Streets With Tracks	Total Yards	Average Age at Time of Repaving: Without Tracks	With Tracks
1892	9,286	.....	9,286	14.00	
1899	27,157	.....	27,157	13.81	
1900	62,939	140,090	203,029	15.51	13.77
1901	22,711	74,385	97,096	14.90	14.05
1902	14,019	9,414	23,433	16.00	10.00
1903	25,426	5,226	30,652	15.81	12.50
1904	27,589	38,738	66,327	17.73	15.13
1905	12,381	35,011	47,392	15.62	16.28
1906	11,012	21,294	32,306	15.96	17.84
1907	28,206	71,235	99,441	19.86	17.77
1908	31,284	13,516	44,800	21.01	17.25
1909	58,455	14,109	67,564	20.88	18.81
1910	54,110	119,197	173,307	20.00	20.43
	379,575	542,215	921,790	17.70	16.35

Average age of all, 16.91 years.

Difference in favor of streets without car tracks is 1.35 years.

date of laying until replacement and that the latter has been at times delayed beyond the proper date. This is true in instances, but it is a condition likely to be quite general. A reasonable allowance for this, should streets be promptly repaved, might indicate an actual full serviceable condition of about 20 years.

Another study of this same problem is made in Table I, which shows the life of asphalt pavements which have been replaced by reason of deterioration, arranged by year of removal. This gives the average life of all at removal as 16.91 years. This cannot be taken as an indication of average life of the pavements laid, but in many instances represents the failure of the poorer or unsuitable fraction of a large number of streets. The average age of those removed in 1909 and 1910 is 20 years, indicating that the poorer streets of the large yardage of 1889 to 1894 have been eliminated.

There are yet in service 76,000 yd. 27 to 30 years old, and also about 6000 yd. 29 to 31 years old, inexpedient for further repairs, but yet in passable condition. Further discussion of probable life, as indicated by repair costs follows.

REPAIRS AND MAINTENANCE—All repairs have been made under contract. For several years during the earlier period of maintenance the surface-heating method was used to some extent with the open or direct gasoline flame. This was abandoned and all repairs made by cutting out to the base.

The following table shows the average cost per yard per year for repairs of all area maintained by the city after expiration of the guaranty period to and including the year named, together with the yard-years maintained:

Year	Total Yard-Years Maintained	Costs per Yard-Year to-Date, cents
1890	300,000	0.97
1891	500,000	1.38
1892	900,000	4.86
1893	1,500,000	4.92
1894	2,300,000	5.09
1895	3,300,000	5.62
1896	4,700,000	5.28
1897	6,400,000	5.13
1898	8,500,000	4.66
1899	10,900,000	4.32
1900	13,800,000	3.92
1901	16,700,000	3.28
1901–2	19,500,000	3.10
1902–3	22,600,000	2.89
1903–4	25,700,000	2.91
1904–5	28,700,000	3.08
1905–6	31,700,000	3.05
1906–7	34,700,000	3.05
1097–8	37,500,000	3.24
1908–9	40,400,000	3.52
1909–10	43,300,000	3.77
1910–11	46,200,000	3.86

That is, for asphalt pavements maintained from the expiration of five- and ten-year guaranty periods to an average age of 17.55 years the cost per yard-year has been 3.86c. The condition of the pavements during this period might fairly be considered as about that usually found. The figures are not given in detail for each year as the variation in condition and expenditures makes such of little general value.

It should be noted from Fig. 1 that the great bulk of this pavement was laid between 1889 and 1895, so that, when the five-year guaranty expired, a great bulk of the pavement was of comparatively small age and this may partly explain the drop in the rate from 1895 to 1903, but much more is explained by the inability of the public and its appropriating representatives to understand the nearly threefold increase in surface to be maintained in 1900 over 1895.

A study has been made along various lines to determine the probable deficiency in appropriations between 1898 and 1907; the result indicates an accumulated deficiency of about $300,000 in 1906-7, or 10c. per yd. Some of this deficiency of repairs has disappeared in repaving streets which might, under proper care, have been useful for a number of years. To the contrary, this neglect undoubtedly caused a higher ultimate cost of repairs on streets having much traffic. What effect it has on the general average cost for the whole period cannot be determined. Any attempt to determine a repair rate based on the age of pavement is somewhat influenced by such deficiency of repairs over a number of years followed by an increase sufficient to overcome the same within a period of about three years.

In consideration of the above average rate of 3.86c. per yd.-year for all maintenance, it should be noted that the streets are now all placed in good condition, that the rate is on streets after a ten-year guaranty since 1898 and that the average age of all pavements maintained at the time of this rate was 17.55 years. If pavements were laid in uniform quantities each year, with a five-year guaranty and an average life of 21 years the average age of those maintained would be but 13 years and with a ten-year guaranty, but 15.5 years as against the average of 17.55 years for this rate.

TABLE II. MATERIALS USED PER SQUARE YARD AND COST OF REPAIRS UNDER UNIT PRICES: BUFFALO ASPHALT PAVEMENTS

	1909 July to Dec.	1910 Jany. to July	1910 July to Dec.	1911 Jany to. Dec.
Cu. ft. per sq.yd. loose,				
Top	1.395	1.345	1.357	1.351
Binder	0.867	0.877	0.780	0.952
In. thick after compression,				
Top	1.622	1.564	1.578	1.571
Binder	1.023	1.035	0.921	1.124
Contract rates,				
Top	$0.385	$0.385	$0.305	$0.305
Binder	0.17	0.17	0.125	0.125
Cement	0.18	0.18	0.16	0.16
Labor	0.33	0.33	0.475	0.475
Cost per yard, complete,				
Top	$0.5373	$0.5180	$0.4138	$0.4119
Binder	0.1473	0.1491	0.0975	0.1191
Cement	0.0128	0.0125	0.0146	0.0208
Labor	0.3300	0.3300	0.4750	0.4750
Total	$1.0274	$1.0095	$1.0009	$1.0268

One square yard 1 in. thick required 0.86 cu.ft. of top or 0.847 of binder as measured loose at the plant.

The larger amount of asphaltic cement used under the last contract was due to its use in filling cracks outside the measured area.

The cost of the actual repair work in the earlier years varied so much and was so complicated with the surface heating or "skimming" work that details are of little interest and have but small effect upon the totals. For the years 1901 to July 1, 1909, the average cost by contract for surface and binder on all repairs was $1.06 per sq.yd. As there was naturally some friction in regulating the amount of materials placed, a new form of contract was prepared and has since been used with most satisfactory results. This provides a price per cubic foot for asphalt surface mixture measured loose at plant and delivered on street; a price per cubic foot for open binder, same conditions; a price per gallon for asphaltic cement hot on street for painting, and a price per square yard for all street labor, chopping, cleaning and laying new material. There is in addition a price per yard for replacing cuts for trench work and other minor items. This is shown in Table II.

These repair contracts carry a guaranty of one year, and, in repairing, any patch overlapping a previous year's repairs more than 6 in. is counted an "overlap" and charged against such previous year's contract. This averages from 1½ to 2% of the area laid and thus brings the actual cost of full area laid to about $1.

In all figures of cost of repairs no charge has been made against the work for inspection or supervision. The relatively high cost of street labor for laying should be considered in connection with the general method of repairs noted below. It is known from the contractors' force account that no such low rate for street labor is possible under our system of repairs as is given for many municipal plants.

In making repairs, when appropriations would warrant, the following considerations have governed. A hole left as such for a time grows rapidly with traffic. If the pavement be old and hard the impact of wheels against the far edge rapidly crumbles the adjoining material. If the pavement be in a more plastic condition the drop of wheels into such depression thins out the top along the near edge, requiring a large cut back to reach a reasonable thickness for a repair joint. On the far side of a hole the wheel impact shoves the material forward, forming a ridge, and wheels dropping from this ridge form a depression beyond, which in time produces another and smaller ridge. This action continued produces a series of ridges and depressions or a waviness which must be removed for proper repair. Similarly any ridge or depression tends to extend a wave condition and is undesirable.

These considerations have led to the policy of preventing rather than filling holes. In marking for repairs the intent is to remove any surface which is in

such condition as to produce a hole before the probable date of next repair, and to remove troublesome ridges and depressions. While not possible entirely to accomplish the desired result, yet the results so far obtained fully warrant a continuance of the policy. The removal of surface having the ear marks of early failure but apparently in serviceable condition, has led casual observers to complain of unnecessary repairs, but it has also eliminated the old complaint of failure of repairs where they were not carried back far enough to reach sound material for a joint.

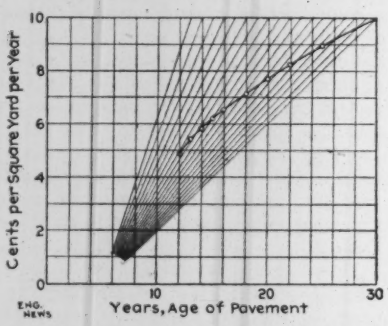


FIG. 3. DIAGRAM SHOWING ERROR OF AVERAGE CURVE OF INCREASE OF COST OF STREET REPAIRS WITH AGE OF PAVEMENT WHEN COST FOR EACH STREET INCREASES UNIFORMLY

The effects of self-propelled vehicles in producing a wavy condition are the opposite of those from the wheels of a horse-drawn vehicle and it now appears probable that a considerable automobile traffic will tend to improve some streets formerly rather rough and uneven.

Two "markers" are steadily employed to indicate all repairs to be made. They have, by long experience, a personal acquaintanceship with their work and can follow it from year to year. They are followed by "locaters" who locate and measure each area marked, the contractor furnishing one man on each tape as his check on measurements. These men are employed during the winter season in plotting all areas repaired and in thus determining the "overlap" covered in previous contracts.

STUDIES OF LIFE AND COST

Unfortunately, the records as kept have not been in a form to show the cost per yard of pavements maintained at different ages, but the rate per yard expended each year on each contract is readily available. It was deemed best not to complicate the following information by including the comparatively short experience on streets paved under a ten-year guaranty, hence only streets paved in and before 1898, under a five-year guaranty, have been studied. The record of 547 contracts is available on pavements laid before that date, and a study has been made by taking the averages of the annual cost rates on these streets to the date of their condemnation, or to 1911, for each year of age. These averages embrace all conditions, suitable and unsuitable, including some alleys and paved bridge floors, but the same weight is given to large and small contracts. All records were kept by calendar years to 1901 when the city changed its fiscal year end to June 30. For all the studies herein, the period Jan. 1 to June 30, 1901, is called a year and thereafter July 1, 1901, to June 30, 1902, is called 1902, etc.

Age of Pavements	No. of contracts averaged	Average repair rate cents	Cost of Total repairs to date, cents	Average cost for Number of yrs.	Rate from $N^2/13$	Totals from $N^2/13$	Average for No. of yrs. from $N^2/13$
1- 5			2.17			2.17	
6	547	0.44	2.61	0.43	1.13	3.30	0.55
7	547	1.53	4.14	0.59	1.43	4.73	0.68
8	547	1.88	6.02	0.75	1.74	6.47	0.81
9	546	2.42	8.44	0.94	2.08	8.55	0.95
10	546	2.74	11.18	1.12	2.44	10.99	1.10
11	546	2.87	14.05	1.28	2.81	13.80	1.25
12	542	3.69	17.74	1.48	3.20	17.00	1.41
13	538	3.88	21.62	1.66	3.60	20.60	1.69
14	519	3.56	25.18	1.78	4.02	24.62	1.76
15	452	3.77	28.95	1.93	4.47	29.09	1.94
16	417	5.87	34.82	2.18	4.92	34.01	2.13
17	372	5.16	39.98	2.36	5.39	39.40	2.32
18	284	6.03	46.01	2.56	5.87	45.27	2.51
19	191	7.07	53.08	2.79	6.37	51.64	2.72
20	139	7.75	60.83	3.04	6.88	58.52	2.93
21	102	7.09	67.92	3.24	7.40	65.92	3.14
22	57	6.78	74.70	3.39	7.95	73.87	3.36
23	29	8.35	83.05	3.61	8.50	82.37	3.58
24	17	8.55	91.60	3.81	9.05	91.42	3.81
25	12	10.12	101.72	4.06	9.61	101.03	4.04
26	10	8.95	110.67	4.25	10.20	111.23	4.28
27	10	10.70	121.37	4.49	10.81	122.04	4.52

The objects sought of these studies were: (1) a general average cost available for comparison with any large city where asphalt has been used under a wide variety of conditions and traffic; (2) a general average suitable for comparison of asphalt with other paving materials; (3) a determination of the probable average life; (4) by division into classes to obtain rate of increase of repair cost with age of pavement and from such, the probable economical life under various conditions.

Some attempts have heretofore been made to obtain these results but apparently, the oversight of important elementary considerations has led to confusion. If it be desired to construct a curve which shows the relation of age to cost of repairs, it will be found that an attempt to average streets of widely diversified conditions will not give results having the characteristics of the elements averaged. This is simply shown in Fig. 3, assuming a group of theoretical streets on which the rate of repairs for each increases directly with the age up to a limit, taken here at 10c. per sq.yd. in the last year of life, the life varying from 13 to 30 years. The curve of average is not a straight line, as are all the elements averaged, but is convex upward or expressed by a function of the age, N, to a power less than unity. Slight consideration will show that the same tend-

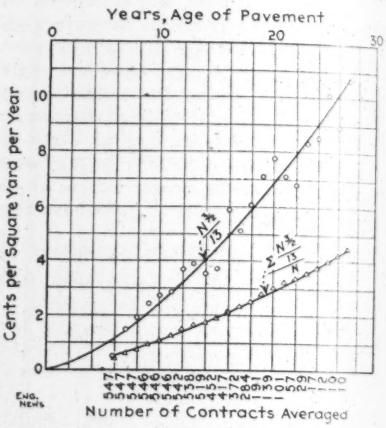


FIG. 4. AVERAGE ANNUAL RATE OF COST OF REPAIRS OF ASPHALT PAVEMENTS IN BUFFALO TO DATE OF CONDEMNATION AND COMPARISON WITH FORMULA $N^2/13$

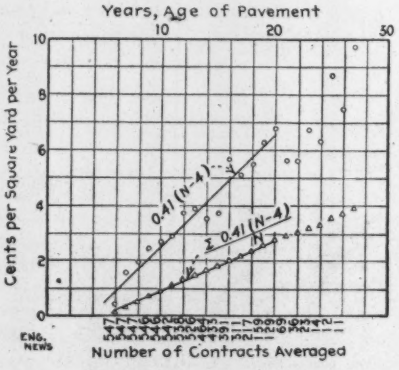


FIG. 5. AVERAGE COST OF REPAIRS PER SQUARE YARD OF ASPHALT PAVEMENTS IN BUFFALO OF DIFFERENT AGES TO DATE OF REPAVING; ALSO LINE 0.41 (N — 4) AND COST-TO-DATE DIVIDED BY AGE

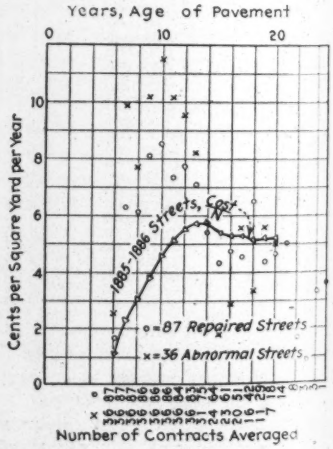

Years, Age of Pavement
Cents per Square Yard per Year
1885-1886 Streets, Cost ÷ N
o=87 Repaired Streets
x=36 Abnormal Streets
Number of Contracts Averaged

FIG. 6. AVERAGE COST OF REPAIRS OF 36 BUFFALO STREETS PAVED IN 1885-86; ALSO AVERAGE COSTS FOR 87 STREETS NOW REPAVED

ency to depression of the curve with increase of age will occur whenever some with a higher rate and shorter life are averaged with those of lower rate and longer life. So it may safely be said that any curve averaging rates for streets with different life periods or characteristics will have a tendency to be depressed with increase of age beyond that of the shorter-lived pavements.

If a number of streets of varying life be averaged and plotted as in Fig. 3, and show an approximately straight line, it must be justly inferred that the characteristic of the increase of cost of the individual street is that of a curve represented by a function of the age, N, to a higher power than unity, as that for the average of all our Buffalo streets is $N^{1\frac{1}{2}}$ and for over 50% is above N^2. It thus seems warranted to say that the rate of increase of repair cost is shown by a curve rising at a greater rate than the age.

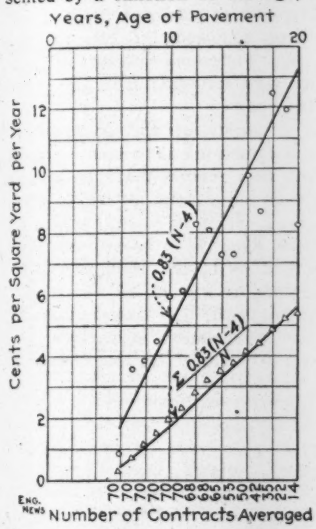


FIG. 7. AVERAGE COST OF REPAIRS ON BUFFALO SHEET-ASPHALT PAVEMENTS WITH CAR TRACKS; ALSO LINE 0.83 (N − 4) AND COST-TO-DATE DIVIDED BY AGE

To make any fair study, the cost of repairs during the period of guaranty should be included and, this not being known, an allowance for such has been made in each analysis for such cost based on the extension of the derived curve backward to the first year of age (except Fig. 6). In the curve for average cost per year for the whole life of the pavement, the life has also been taken back to the beginning, as no reason can be seen for not making a guaranty period a factor in determining average repair costs.

To make clear the method used in the construction of the different diagrams illustrating repair rates, the necessary data are given in the table with Fig. 4 for the average of all contracts. In this table, column one shows the age of pavement, column two the number of contracts averaged for the result, column three the average annual expenditure in cents per yard, column four the expenditure to and including the given age with allowance for repairs during the guaranty period, column five the average cost per year of life to that age. For the purpose of reducing this to a workable expression, the form of $\frac{N^{1\frac{1}{2}}}{13}$ has been worked out, N being the age of pavement in years. Column six shows an annual rate, column seven the sum of rates, column eight the average per year of life to that age. The greatest departure of column eight from column five after the sixth year is but 0.11c., and the total departure ½c., up to and including the 27th year.

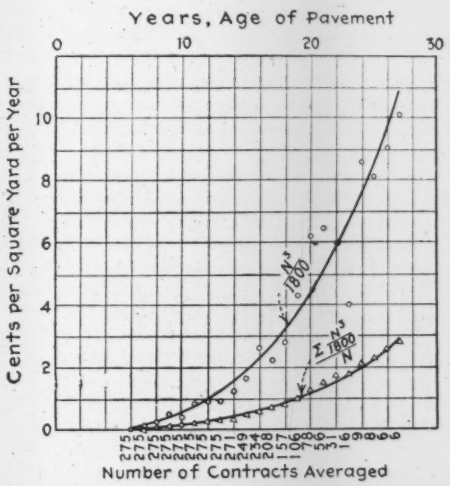


FIG. 8. AVERAGE COST OF REPAIRS ON BUFFALO SHEET-ASPHALT PAVEMENTS WHERE STREETS WERE FIT AND WELL CONSTRUCTED AND WITHOUT CAR TRACKS; ALSO CURVE $\frac{N^3}{1800}$ AND COST-TO-DATE DIVIDED BY AGE

This curve, while so closely approximating the actual costs shows that the latter lie slightly nearer a straight line and that the actual costs are smaller at the early periods.

A similar computation was made on these same streets up to the time of repaving, instead of to condemnation,* and such is expressed best by 0.41 (N-4), this showing a closer conformity to actual rates up to 20 years, the greatest variation from the actual average annual cost to any year being but 0.08c., shown in Fig. 5. All investigations made seem to show that the repairs during the first four or five years are small. This depression of the curve into a straight line, arising from the inclusion of streets between condemnation and repaving also illustrates a reason for some straight-line assumptions. These expressions of $\frac{N^{1\frac{1}{2}}}{13}$ to condemnation or 0.41 (N-4) to repaving, of course, are not applicable to any given class of streets, but are composite results of a varied experience.

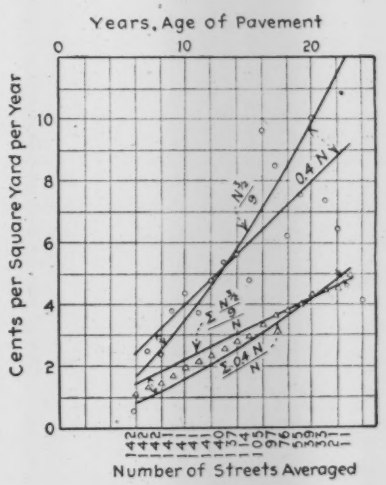


FIG. 9. AVERAGE COST OF REPAIRS ON 142 STREETS NOT INCLUDED IN FIGS. 7 AND 8, TO DATE OF CONDEMNATION; ALSO CURVES $\frac{N^{1\frac{1}{2}}}{9}$ AND OAN AND COST-TO-DATE DIVIDED BY AGE

They might be reasonably used for estimating the total cost of repairs under similar conditions and for determination of the relative ultimate cost of asphalt compared with other pavements.

A disturbing element in all cost curves, except that for the best 275 streets, is the abnormal record of 36 streets, paved in 1885-1886, which were much below the average in quality and high in repair costs. All but four have been repaved. The average annual expenditure per yard for these 36 streets is shown in Fig. 6 by (x) and a curve is sketched through points of *"Cost-to-Date/N"*. There are also added to this diagram, the average annual expenditures on 87 streets which have been repaved, indicated by the triangle symbol.

To arrive at results which might be reasonably applicable to any certain class or condition of street, the above 547 contracts were divided into five parts. The

*Streets have not been repaved immediately after cessation of repairs by reason of condemnation. Fig. 4 is based on average repair costs on streets under maintenance, while in Fig. 5 the same costs or expenditures are divided by the number in use, although some were not being maintained. There may be a reasonable question as to where the limit should be drawn for the end of a pavement's life; hence the curves were constructed for both conditions.—G. H. N.

first separation was of those of abnormal conditions—bridge floors, streets with car tracks in but part, or for but a part of the time, etc., as of no value and not used outside of Figs. 4 and 5.

The second division was of 70 contracts for streets containing street-car tracks. An expression for average annual costs to fit the actual figures would involve the use of N to a power less than unity. This is due to the high cost of some streets from the 10th to 15th year when they were lost from the average by repaving and only the more suitable remained. The rate of repairs for these 70 car-track streets to date of condemnation is fairly well shown by 0.83 $(N\text{-}4)$. The yearly cost,

$$\frac{\Sigma\ 0.83\ (N-4)}{N}$$

is about 0.25c. lower from the ninth to the 15th year than the actual cost. The departure becomes marked after the 20th year, as but a few of the most suitable remained and had a relatively lower repair cost, shown in Fig. 7.

The next separation was of 16 alleys, mostly with center gutters, these showing practically the same characteristics and rates as the car-track streets. Of the remaining streets, after the three eliminations noted above, a separation was made into two classes, depending upon cost of repairs. The first being those in which the cost of repairs from the sixth to

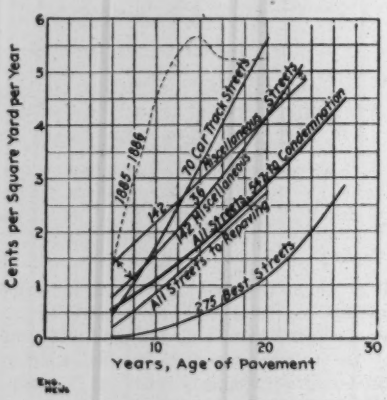


FIG. 10. AVERAGE COST OF REPAIRS FOR TOTAL LIFE OF VARIOUS CLASSES OF BUFFALO SHEET-ASPHALT PAVEMENTS

17th year, inclusive, was 25c. or less, the streets less than 17 years old being divided on a cost of 10c. at 13 years. The remaining streets form the fifth class.

These 275 contracts out of 547, divided on repair cost of 25c. at 17 years or 10c. at 13 years age after a five-year guaranty, show a curve even sharper than N^3, but assumed at $\frac{N^3}{1800}$, and are believed to more truly show a normal increase curve than any of the other divisions made. Shown in Fig. 8.

This record of a repair rate of 1.87c. at 15 years, 4.45c. at 20 years and 8.68c. at 25 years, based on 275 contracts or over 50% of our experience, is believed to fairly represent what asphalt pavements should cost laid where and as they should be, unless their desirability in less favorable locations warrants the added expense.

The other streets of miscellaneous conditions, 142 in number, being exclusive of car-track streets, alleys and those included under $\frac{N^3}{1800}$ are, as would be expected, not easily expressed in any definite terms, but average out between a line 0.4 N and a curve $\frac{N^2}{9}$, both of which are plotted in Fig. 9. By the yearly average cost rates it is seen that the true line is about midway between the two drawn. These streets include the failures of 1885-6, other streets where the surface mixture was undoubtedly poor and where poor natural-cement-concrete bases were laid over wet soil, and many fair streets in which the repair cost ran but little above the repair limits used for separation of the best streets. While this separation has not as yet been made, it is probable that about one-half this number would be

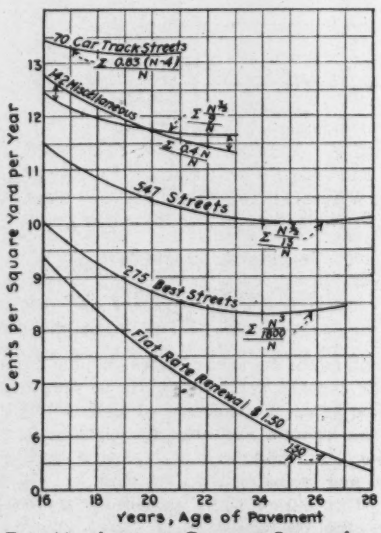


FIG. 11. ANNUAL COST OF SHEET-ASPHALT PAVEMENT ON STRAIGHT-LINE SURFACE RENEWAL AND VARIOUS REPAIR RATES

represented by a parabola (a study of 25 of various ages showing $\frac{N^2}{70}$).

For the purposes of comparison, the average annual cost curves are grouped in Fig. 10. This shows no justification for assumptions sometimes made of an average cost rate of from 5 to 7c. per yd. per year where the life is assumed as less than 20 years for any average conditions.

These curves readily provide for determination of the annual cost of providing a pavement of this kind over a long period. The elements dependent on life and repairs are, (1) allowance for renewal, or depreciation if desired to so term it, and (2) annual cost of repairs. It is not intended to make this a discussion of the proper method, but to show the results. It is first assumed that the cost of renewal, or the depreciation, is charged off at a flat annual rate. The cost of renewal of the asphalt top has been here assumed at $1.50, this depreciation curve plotted in Fig. 11 and, by added ordinates, the various curves of Fig. 10 have been plotted above it. The same method was followed for Fig. 12, but with a 4% compound-interest sinking-fund allowance for renewal in any given number of years.

While a variety of sinking-fund and bond-issue conditions have been assumed in several able reports made on paving costs, a more simple and rational solution is available. If it be assumed that an unimproved street is to be provided with a perpetual pavement there are four items of importance to be considered: (1) original cost, (2) depreciation of base, (3) depreciation of surface, and (4) repair of surface. In most cases the

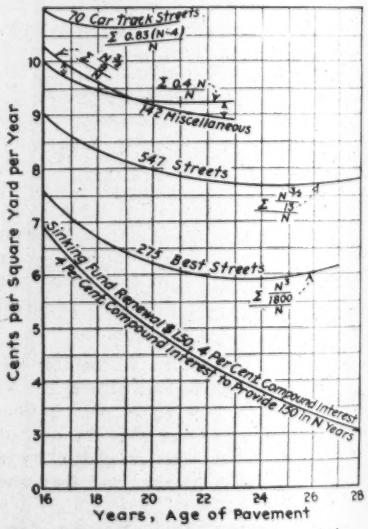

Cents per Square Yard per Year
Years, Age of Pavement
70 Car Track Streets
142 Miscellaneous
547 Streets
275 Best Streets
Sinking Fund Renewal $1.50, 4 Per Cent Compound Interest
4 Per Cent Compound Interest To Provide 150 in N Years

FIG. 12. ANNUAL COST OF SHEET-ASPHALT PAVEMENT ON 4% SINKING-FUND SURFACE RENEWAL AND VARIOUS REPAIR RATES

original cost is either paid for directly by the property holder, or else the city makes definite financial arrangements for payment, so that the future burden is practically that of an interest charge on original cost. The second item is for renewal of base, curbs, drainage, etc.; these elements will undoubtedly last, on the average, twice as long as the top, so that a life of 40 or 50 years may be assumed. This may be computed on a flat-rate or

sinking-fund basis. In fact, few if any cities make a tax levy or otherwise attempt to provide such a sinking fund and computations on that basis are theoretical. The other two items are as covered by Figs. 11 and 12. Assuming the cost of grading, curbing, drainage, etc., on an asphalt street at $1.50, with a life of 40 years, and that the renewal of the top will cost $1.50; the cost to Buffalo on its better streets would compute on a sinking-fund basis:

4% interest on original cost ($3)	$0.12
To renew base, curb, etc., in 40 years	0.016
Repairs and top renewal from Fig. 12	0.059
	$0.195

On a flat-rate depreciation,

4% interest on original cost ($3)	$0.12
To renew base, curb, etc., in 40 years	0.0375
Repairs and top renewal from Fig. 11	0.083
	$0.2405

The costs for the average of all streets computed as above would be $0.213 on sinking fund and $0.258 on straight depreciation. Thus these streets could have been provided on a long-term sinking-fund financial arrangement under 22c. per yd.-year or on a flat-rate renewal basis under 26c. per yd.-year.

There can be no question as to the economical life being the proper life limit for any pavement. The curves plotted in Figs. 11 and 12 (excepting one) show minimum values. These curves being expressed by various functions of the age may be solved for these values of N mathematically, or read from the diagram. They show an economical life for car-track streets of about 19 years and for average and best streets of about 24 years. However, these values are subject to the limitations and cautions in their use discussed above and illustrated by Fig. 3. No average curve can be used for a particular street. Unless streets are closely classified, the average curve cannot be used to determine an average economical life. This is at once seen from Figs. 11 and 12, where the minimum-cost point for the average of all streets is at a greater age than for either car-track streets or the best streets owing to the distortion of the curves. The classification is so close on the best streets that the value shown, about 24 years, is believed to be not much in excess of the true value. From these diagrams it may be reasonably assumed that 50% of all streets will reach a life of 23 years, 25% car-track streets, alleys, etc., will have a life of 18 years, and the miscellaneous 25% will show a life of 20 years. These assumptions give an average life of 21 years for all as a check on the estimate made at first from records of repaving.

For condemnation of a street, its individual record should be taken and treated as in the table with Fig. 4. This is shown in full in Table III for one of the older streets, shown both for flat-rate and sinking-fund depreciation, with allowance for probable repair during the five-year guaranty period. This is a residence street with a considerable amount of travel, paved in 1882, 22,500 sq.yd. The variation in rates of different years is well illustrated by this street which may be called typical of the actual variation in amounts expended each year on an individual street. The various reasons entering into this are not here discussed. Column six shows the average cost of pavement per yard-year to any given age of pavement. It shows a fictitious minimum for the 26th year when no repairs were made and a probable true minimum in the 27th year, hence it might well have been relaid in its 28th year. This tabular arrangement has an immediate use in showing the allowable rate of repair for any year approaching the critical age. If the sum of the flat depreciation and average repairs at any year be expended in repairs the following year the total for such year will be the same. This is readily obtained in simple algebraic form, for the (N)th and $(N+1)$st years. From this column six the allowable rate for repairs in the 28th year was the cost shown for repairs and depreciation in the 27th year, or 8.5c., and this rate could be continued indefinitely without violating a minimum-cost rule. However, 12.9c. were expended in the 28th year and 6.9c. in the 29th year, a total of 19.4c. against an allowable $2 \times 8.5 =$ 17c. To bring the cost back to 8.5c., it will be allowable to expend $8.5 \times 3 -$ $19.4 =$ 6.1c. per yard in the 30th year.*

TABLE III. RECORD OF ONE BUFFALO STREET, 22,500 SQ. YD.; SHOWING DETERMINATION OF MINIMUM COST AND ECONOMICAL LIFE. (ALL COSTS IN CENTS PER YARD)

Age N	Annual Cost of Repairs	Total Cost of Repairs	Average Annual Cost of Repairs	Annual Allowance for Renewal	Annual Cost of Pavement	Sinking Fund Payment at 4%	Annual Cost on Sinking Fund Basis
1 to 5		3.0					
8	2.7	5.7	0.7	18.8	19.5	16.3	17.0
9	0.8	6.5	0.7	16.7	17.4	14.2	14.9
10	12.9	19.4	1.9	15.0	16.9	12.5	14.4
11	4.9	24.3	2.2	13.6	15.8	11.1	13.3
12	0.6	24.9	2.1	12.5	14.6	10.0	12.1
13	2.1	27.0	2.1	11.5	13.6	9.0	11.1
14	2.2	29.2	2.1	10.7	12.8	8.2	10.3
15	1.4	30.6	2.0	10.0	12.0	7.5	9.5
16	0.9	31.5	2.0	9.4	11.4	6.9	8.9
17	2.9	34.4	2.0	8.8	10.8	6.3	8.3
18	3.0	37.4	2.1	8.3	10.4	5.9	8.0
19	0.3	37.7	2.0	7.9	9.9	5.4	7.4
20	3.1	40.8	2.0	7.5	9.5	5.0	7.0
21	5.8	46.6	2.2	7.1	9.3	4.7	6.9
22	3.5	50.1	2.3	6.8	9.1	4.4	6.7
23	9.6	59.7	2.6	6.5	9.1	4.1	6.7
24	5.9	65.6	2.7	6.3	9.0	3.8	6.5
25	4.2	69.8	2.8	6.0	8.8	3.6	6.4
26		69.8	2.7	5.8	8.5	3.4	6.1
27	8.3	78.1	2.9	5.6	8.5	3.2	6.1
28	12.5	90.6	3.2	5.4	8.6	3.0	6.2
29	6.9	97.5	3.4	5.2	8.6	2.8	6.2

*Note—The 30th year's repairs, just made on this street, limited to repairs of breaks and weak spots outside of gutters, cost but 2.3c. per yd. It was intended to condemn following this repair. This leaves open the nice question of the possibility of reaching a condition of continuous maintenance by repair within the economical limit.

It may be noted that even this 1½c. increase in rate for a period of 29 years on 22,500 yd. amounts to over $650, indicating the advisability of closely determining a minimum-cost life. The effect of a thorough repair, as in the 28th year of this pavement, may be to put a street in condition where another and correct minimum-cost point may be reached after a number of years. Experience and judgment only can determine this. Another element enters for consideration along this line. The minimum cost for the street must be obtained over a long period. If this street is showing a rate below what may be expected by average experience from a new surface then it may well be carried along, but if it shows a rate above what may be reasonably expected of a new surface on this class of streets, then an earlier resurfacing may be determined in doubtful cases.

The other items entering into this problem, such as greater desirability of a new surface for accommodation of traffic, the inconvenience caused by the work and the necessarily attendant expenses may well be expressed in the net-cost figure assumed for the renewal.

Where the proportions of expense for repairs and renewals are not the same for general and local taxation, in justice to both the property owner and the engineer there should be some definite rule established for repair limits which may be readily explained and understood. The above method of treating the individual street on its own record by a straight-line renewal or depreciation allowance seems a simple and reasonable solution. From it may be formulated the rule that the allowable repairs in any year should not exceed the sum of the total cost of repairs to date, plus the cost of renewal, divided by the age of pavement, and when the necessary repairs will exceed such sum the street should be repaved.

It is hoped that similar repair cost records, particularly of cities maintaining a municipal asphalt-repair plant, may be made available for comparison of contract and municipal-plant costs, not on the cost of a square yard of repair, but upon maintenance results obtained.

Each city has had its extended experience with some variety of pavement. If a common basis of computation be taken, such as 4% interest and a flat-rate renewal provision, then cities of similar size, climate and traffic conditions may compare experiences as to costs of various pavements and all be enabled to have available a fair foundation of fact for determination of kind. With such basis, the further considerations of noise, traction resistance, foothold, ease of cleaning, sanitary value, etc., may each be given its relative value and thus a fair engineering determination be made.

Under the above assumption, Buffalo may say that a sheet-asphalt pavement

can be provided over a long term for 29c. per yd. per year under unfavorable conditions, for 26c. under an average of all conditions and for 24c. under average fair conditions.

The use of portland-cement-concrete base and a fuller knowledge of the materials may fairly be expected to reduce these figures in the future.

Some Important Street Improvements in Pittsburgh

A remarkable amount of municipal improvement work is being carried on in Pittsburgh, Penn., at the present time and more is projected. The total expenditure which the present improvements involve is not unusually large, but the variety and distribution of the work, the interesting technical features involved, and the great importance of the work in developing the city area, make it well worth a general review.

The improvements now under way include: Filling low-lying areas exposed to floods; cutting down a hill in the heart of the business district; widening and paving several hillside and riverside streets, which require a mile or two of difficult retaining-wall construction; sewer reconstruction; building a large steel bridge over the Allegheny River; building half a dozen concrete arch bridges, one of them the longest arch span in America; and extending the city's well known filtration plant in several notable particulars. One interesting piece of grade-crossing elimination is also under way, in connection with one of the street improvements. But generally speaking the topography of Pittsburgh makes the grade-crossing problem relatively unimportant, except at one or two points where the conditions have become troublesome and require prompt relief. Further grade-crossing abolition is to be started within a year.

In the present article we can deal only with the grading and street work, leaving the bridge work for separate discussion in a future issue. Sewer work, which finds only brief mention in the present article, also receives much attention in the Department of Public Works, but as the local conditions present unusually complex problems in respect of sewerage, it is expected that a fuller account of Pittsburgh's sewer improvements will be presented separately at another time, so that only passing mention is made of sewers in the present summary.

FIG. 1. FILLING IN NORTH SIDE FLOOD DISTRICT; ISABELLA ST.

(The left-hand side of the street shows how most of the buildings of the district are affected by the fill. At the right a building is being raised).

Two much more unsettled fields of improvement, which also have been in the air during the past year or two, are: (1) General flood protection work, and (2) Construction of a rapid-transit subway system. Both of these have advanced to a definite preliminary stage, but at present are stationary. Some months ago the flood commission, a private association of citizens, completed a voluminous report on flood protection, recommending extensive and costly protective works. It is expected that the proposed river wall around the lower part of the city, recommended in this report, will be included in a referendum on new bond issues this fall. In the matter of the subway the city council recently passed a permissive ordinance, after several months of active discussion over terms and procedure. This ordinance leaves the field open for construction of a subway system by a private company. No proposal under this ordinance has yet been made, however, and it is possible that the matter will rest in this condition until the city undertakes construction on its own account.

LARGE GRADING PROJECTS

Three important regrade enterprises are in progress. One is a grade-lowering and two are grade-raising enterprises, all situated in radically different parts of the city area. In each case the influence upon private property is very great, and the amount of alteration and rebuilding which the municipal work

FIG. 2 AND 3. NORTH SIDE FILLING; RIVER AVE. IN FLOOD TIME, AND DURING THE FILL IMPROVEMENT

(Left-hand view taken from Federal St., looking east, Mar. 2, 1912. Right-hand view taken looking west toward Federal St., in the same block, showing the retaining-wall for the fill under construction, Apr. 11, 1912).

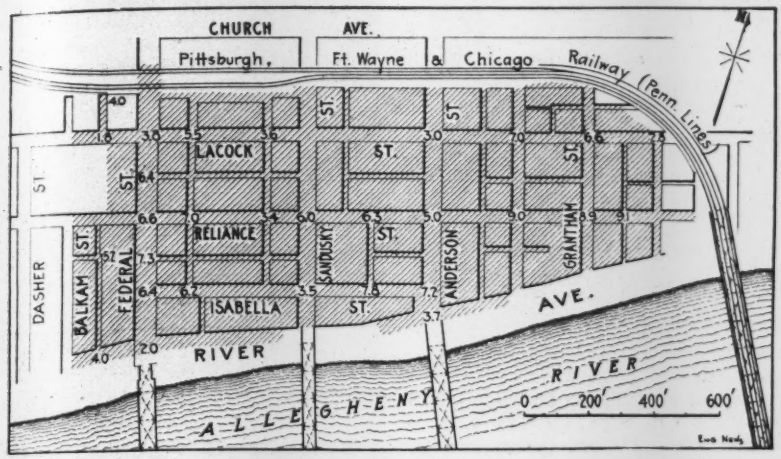


FIG. 4. SKETCH MAP OF NORTH SIDE FLOOD-FILL DISTRICT

brings about is a clear index of the importance of the regrade undertakings to the community.

The two grade-raising projects are undertaken for flood-relief purposes, one on the North Side and one in the West End. The third, the "Hump Cut," in the central part of Pittsburgh's business district, is a traffic improvement; this has already been mentioned, in our issue of Jan. 11, 1912, where a map was shown, and more recently in our issue of July 4, 1912, giving one or two views of the work in progress.

FILLING OF NORTH SIDE FLOOD DISTRICT

An area of some 40 acres on the river flats of the North Side (the old city of Allegheny) is being filled an average depth of 4 ft., maximum 10 ft., to do away with the overflow at extreme flood stages of the Allegheny River. Lying directly opposite the main portion of lower Pittsburgh, between the tracks of the Pittsburgh & Western Ry. (B. & O. system) along the river bank and the Pittsburgh, Ft. Wayne & Chicago Ry. tracks about 1000 ft. inland, this flood district includes the main avenues of traffic between Pittsburgh and Allegheny. The principal streets traversing it correspond to the three important Allegheny River bridges, Federal St., Sandusky St. and Anderson St. (the old Sixth St., Seventh St. and Ninth St. bridges), which are the sole highway connections between the two banks for a long distance. A portion of Sandusky St. on the North Side had been raised in the past to a level practically above danger of flooding, but the rest of the district was exposed to flooding at the highest stage annually reached (see the view, Fig. 2).

The sketch map of this flood district, Fig. 4, illustrates the extent of the work. The fill area is about 2000 ft. long, by about 800 ft. wide. Its occupancy is about equally divided between low-grade dwellings and business buildings. Containing but few modern buildings the district requires very extensive private work in order to bring the buildings into harmony with the new street grades. This may be judged from the views Figs. 1 and 3. Although the grade-raising work began more than a year ago, the raising or removal and replacement of buildings has been going on slowly, except along Federal St. It may be expected that the probable extensive changes in the nature of occupancy of the district will delay the adaptation to the new grade, as it is likely that most of the dwellings will be replaced by warehouse and business buildings.

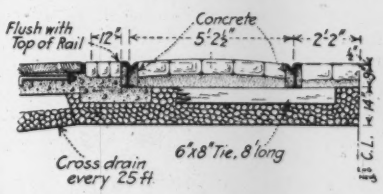


FIG. 5. Z-BAR INNER CURB OF WOOD-BLOCK PORTION OF STREET WIDTH

The conduct of the work may be described in brief as follows: Material for the fill was in large part dredged from the river, and teamed from a receiving plant with dumping-board on the river bank at the west end of the district. During the 1912 season much material was brought from the "Hump Cut," which is carried on by the same contractor. In the case of this latter material, much of which is rock, the specifications require it to be thoroughly mixed with clay and river gravel to make a mass that will pack down firmly. Before filling could begin, the pavements and curbs were taken up and the necessary attention was given to changes in the substructures. The sewers were generally left in place at their existing grades, the catch-basins and manholes being either extended or rebuilt. The water pipes were replaced by new lines laid generally so as to give 4 ft. cover under the new surface. The old lines were either removed or abandoned after the new lines were in service. Gas pipes and wire ducts were handled in a similar way, this work, however, being at the cost of the companies. In the district in question most of the wires were on poles and thus were not much affected by the fill operation.

The specifications required the fill to be deposited in layers not over 6 in. thick and to be rolled with a 10-ton roller (or in inaccessible places tamped with iron rammers). Pavements were laid directly on the finished fill subgrade as a rule, without waiting for slow settlement, the tamping and rolling being supposed to be thorough enough to prevent settlement. Various kinds of pavements were laid in this district. On Federal St. wood-block paving was laid, elsewhere generally stone-block, and in the alleys vitrified brick with bituminous grouting. All these classes of pavement were laid on concrete base. The stone-block pavement is Class A, which consists of uniformly cut blocks of Ligonier limestone, which give a very even surface.

In the creosoted wood-block paving a new detail was introduced for protection along street-car tracks. It has been found with this class of pavement at other points that settlement and rutting occurs along the joint between the wood blocks and the stone blocks which border the rails of the street-car track; the street-car company is required to take care of the paving 12 in. outside of its tracks, but is not bound to use the kind of paving specified or preferred by the city authorities and in consequence generally uses stone blocks on broken-stone base. A detail introduced with a view to preventing settlement at this point is shown by the sketch, Fig. 5. A longitudinal Z-bar laid flat is set under the wood blocks adjoining the stone blocks, resting on the concrete base and tied back into the concrete with long bolts. This arrangement provides firm support for the wood blocks along the joint and prevents them from tipping or sinking, and to some extent prevents the formation of a rut.

This work was placed under contract May 26, 1911, Booth & Flinn being the contractors. It is now about 75% completed; final completion is expected before the end of 1912. The contract price was $186,893. This figure includes the shifting of water mains. Some contract-price items are included in a tabulation at the close of this article.

WEST END FLOOD IMPROVEMENT

On the south side of the Ohio River, about a mile below the Point, Sawmill Run enters the Ohio. The lower courses

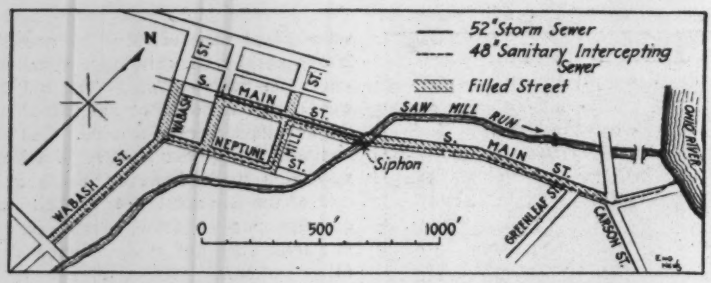


FIG. 6. SKETCH MAP OF WEST END FLOOD-FILL DISTRICT

of this creek were poorly drained, and sufficiently low in elevation to be flooded at high stages of the river. Conditions were made worse by the fact that all the sanitary drainage of the district was discharged into Sawmill Run, which in consequence became in time a serious nuisance; for the improvement of these conditions, the low-lying streets are being filled to an elevation above flood level and a sanitary intercepting sewer is being constructed parallel to the creek to an outfall in the Ohio. The sketch map, Fig. 6, gives the location and shape of the fill district. Its maximum length is about 3500 ft. The fill ranges from about

FIG. 7. WEST END FLOOD DISTRICT WORK

(South Main St., near Mill St. The height of filling is roughly indicated by the distance the frame building is being raised).

4 ft. average to a little over 10 ft. maximum.

The number and value of buildings in this district is small; yet the property owners have met the situation with considerably more energy than was exhibited in the North Side fill district. Nearly all buildings have already been raised to the new grade and placed upon new foundations, in spite of the fact that the work is in only its earlier stages. Fig. 7 exemplifies this.

An interesting feature of the fill work in one of the streets is that an 18-in. gas main is being raised bodily, in slow stages, instead of being rebuilt at a higher grade and the old line abandoned.

The intercepting sewer, already mentioned, is the most interesting item of this improvement. It is a 48-in. circular concrete sewer designed for the ultimate drainage of a population of 200,000, estimated for the large drainage area of Sawmill Run. But the present population to be served is only about 5000, and thus rather awkward hydraulic conditions are to be expected in the early years of the sewer. The sewer (on uniform grade of 3½ ft. per thousand) will be fitted with flushing gates by means of which it can be flushed by impounding the sewage; this operation carried out about once a week is expected to keep the sewer in a reasonably clean condition. Special provision has also been made at an inverted siphon crossing under Sawmill Run for accommodating the successively increasing flow, by providing three siphon pipes of different sizes, connecting the same downtake and uptake chambers.

A few short sections of storm sewer are included in the improvement, only one of them being of large size, 52 in. This latter is provided with 30x60-in. floor gratings for diverting the dry-weather flow to the sanitary intercepter, while discharging the storm water into the Run.

The construction of the sanitary intercepter, as well as of the storm sewers built in the district, includes putting in house laterals at all lots to a point 5 ft. inside the curb line, to facilitate future connections. This procedure is also being followed in other recent sewer work in Pittsburgh where large sewers are involved.

The contract for the West End Improvement was let Oct. 14, 1911, to James McQuade & Co., for the price of $137,015, this price including the sewer work. It is approximately half done at the present time, and is expected to be practically completed by the end of 1912. The street repaving, about 8800 sq.yd., includes about two-thirds stone-block paving and one-third asphalt block and sheet-asphalt pavement, all on concrete base. The successful bidder's figures for the chief items are included in the table on p. 576.

The fill material is in part obtained from miscellaneous nearby sources, and in part from the "Hump Cut." The latter material is brought by team, a ha[ul] of about 2 miles. It is claimed tha[t] ve loads per day is handled by each [te]m, on the average. In the principal [st]eet traffic must be maintained, and the [fi]ll is required to be put in on half the [wi]dth of the street to provide a vehicle [wa]y, before the other half is interfered [wi]th.

Extending westerly from the lowe[r] end of the West End flood-fill district i[s] the West Carson St. improvement, deal[t] with farther below. The two improvements in conjunction are of great importance in connecting Pittsburgh with the boroughs and towns to the west, both West Carson St. and Main St. being main thoroughfares and having hitherto been in exceedingly unsatisfactory condition.

THE HUMP REGRADE

The "Hump Cut" involves the district extending north from Fourth Ave. to Seventh Ave., and about 1000 ft. east from Smithfield St. The depth of cut is 14.9 ft. at Fifth Ave. and Grant St., which may be regarded as the governing cut, although slightly greater depths of cut are required at a few other crossings. This represents an increase of about 3 ft. in cut over the project for which plans were prepared in 1910.

Street grading for the purpose of reducing the steep slope up from Smithfield St. to Grant has been more or less in the air for many years past. That the work would be undertaken sooner or later was so firmly believed that a number of the newer business buildings of the district were planned and built to allow of ready adaptation to a lowering of the grade. The Frick Bldg., on Fifth Ave., corner of Grant St., and the County Court House, just east of this across Grant St., are the most prominent examples. The basement of the Frick Bldg. in particular was so detailed as to adapt itself readily to service as the first story after a cut of 15 to 20 ft., and the present cut of 14.9 ft. will thus be readily taken care of. A similar statement applies to the Court House. Most of the older buildings, however, require extensive reconstruction, and as this in many instances is uneconomical they are being removed to be replaced by modern structures. The views, Figs. 8 and 9, give a fairly clear picture of these conditions as well as representing graphically the depth of cutting.

The contract for this work was let on Apr. 5, 1912, after a rather unusual situation in which the low bidder (Jas. McQuade & Co.) declined the award of the contract, so that the work was awarded to the next bidder, Booth & Flinn, Ltd. The contract price is $671,450. The work is to be completed by the end of 1913, but its first division, comprising Fifth Ave. and the adjacent portions of the cross streets, must be completed so as to carry traffic before the second division can be undertaken. It is expected

FIG. 8. LOOKING DOWN FIFTH AVE. FROM CHERRY WAY TO SMITHFIELD ST. EXCAVATION TO NEW GRADE. OLD GRADE REPRESENTED BY TEMPORARY SIDEWALK

FIG. 9. VIEW IN WEBSTER AVE., SOUTHWEST TOWARD GRANT ST. SHOWS THE EXTENSIVE DEMOLITION AND RECONSTRUCTION RESULTING FROM THE HUMP CUT

that the first-division work will be about completed by the end of 1912.

As the contract with the city does not cover the change of grade of the trolley tracks, gas mains, wire ducts, etc., and (while including the sewers) does not include the water mains, a very considerable addition must be made in estimating the total cost of the work. It is figured that the city's share of the work, including water mains and miscellaneous expenses, will somewhat exceed $750,000. The work done for private companies in street substructures* will probably amount to over $500,000, bringing the total to between $1,250,000 and $1,500,000. The reconstruction of buildings involves a very great additional cost, not subject to estimate at the present time. About three-fourths of the property owners waived damages, without which advantage the city would probably not have undertaken the cut. The damages which will have to be paid are not included in the above figures of total cost.

Work was begun on Apr. 5, the day of awarding the contract, and has been continued since then at a rate slightly exceeding that necessary for completion within the contract period. The total volume of excavation required in the city's contract is about 143,000 cu.yd. About two-thirds of this material will have to be wasted, the remainder being used in the flood-district filling on the North Side and in the West End. The material wasted is teamed over a trestle constructed in the prolongation of Shingiss St. over the railroad yards along the Monongahela River, and from here is dumped into cars.

After the removal of the old paving and taking care of those pipe lines which required changing before excavation, a steam shovel was started, and cutting directly to grade by excavating from a vertical bank it progressed through Fifth Ave. and Grant St. between Sixth and Fourth Aves. and other adjoining streets comprised in the first division. Practically the entire cut was in rock, the shaly material which composes most of the Pittsburgh subsoil. Light charges of explosives were used to loosen up the rock, direct cutting with the shovel being not practiced.

In the matter of taking care of piping, wire ducts, etc., the methods adopted varied, depending upon local conditions. The gas mains were in general provided for by temporary lines strung under the temporary sidewalks. The two gas companies in some instances joined interests, dividing up the two sides of a street so as to avoid duplication of pipe under a single sidewalk. Water lines, where they could not be cut out, by reason of lack of supply from another street, were generally maintained in their original position until excavation was down to grade and new mains could be laid in trenches below subgrade. The sewers where necessary were reconstructed below the old level in trenches dug from the original surface before excavation started. In other cases the old sewers were kept in service during the excavation, the prism of rock under the sewer left undisturbed as a support until the excavation was completed, and the new sewer trench started from subgrade. The telephone and electric-power wires were taken care of either by putting new ducts below the new grade in trenches from the old level before excavation started, or by carrying them on pole lines temporarily until the new ducts could be placed from the excavated subgrades. In one instance a new duct bank was put down by a trench 21 ft. deep, the old duct being left to be wrecked.

Before any of this work was undertaken, the street cars were re-routed through Fourth and Sixth Aves., and through Diamond St. easterly of Grant St. The sidewalks were replaced by temporary board walks, built somewhat

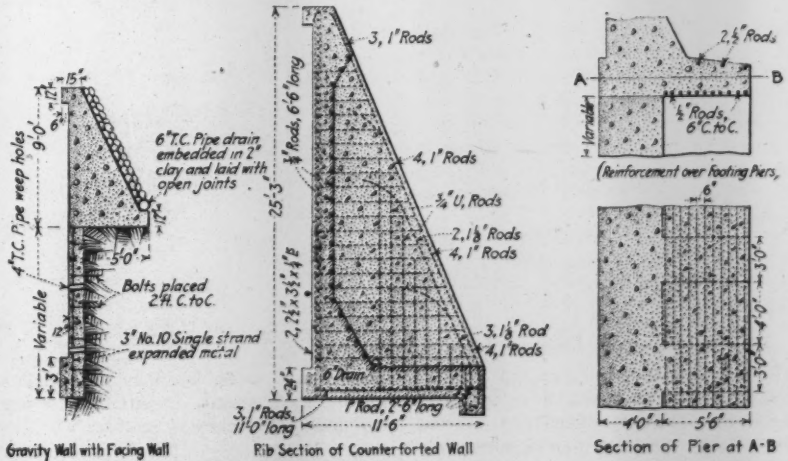

6" T.C. Pipe drain embedded in 2" clay and laid with open joints
4" T.C. Pipe weep holes
Variable
Bolts placed 2 Ft. C. to C.
3" No. 10 Single strand expanded metal
Gravity Wall with Facing Wall
3, 1" Rods
¾" Rods, 6'6" long
4, 1" Rods
¾" U. Rods
2, 1½" Rods
4, 1" Rods
3, 1⅛" Rod
4, 1" Rods
6" Drain
3, 1" Rods, 11'0" long
1 Rod, 2'6" long
11'6"
Rib Section of Counterforted Wall
2½" Rods
A
B
½" Rods, 6" C. to C.
(Reinforcement over Footing Piers)
Section of Pier at A-B

FIG. 10. TYPICAL WALLS IN SOUTH 18TH ST. IMPROVEMENT

*Nine companies are affected: Two extensive telephone systems, three large gas systems, the street-railway company, one light and power company, and two companies having minor electric conduit installations.

above the level of the old walks and supported on posts from the excavated level. These walks are required to be maintained until the new sidewalks are ready for use, that is to say, until the new streets are practically finished. Only a few of the principal sidewalks of the district, however, are provided for in this way.

In the design of the new street cross-section, special care was given to providing a uniform system in accommodating the street substructures. The space between elevations 3.75 and 4.50 ft. below top of curb was reserved for water-service pipes by requiring that all company pipes and ducts must be above or below this space. The water main was generally placed in the center line of the street, approximately 4 ft. below top of the curb, while the sewer was placed to one side of this at a suitably lower level. Within the restrictions above stated, the location of pipes and ducts was adapted to the needs and preferences of the different companies, all structures, however, being kept as close to the curb as practicable. Generally speaking the small gas-pipes and other structures are above 3.75 ft., while the large gas-mains and banks of ducts are placed below 4.50 ft. All structures were allotted different vertical widths in order to permit access to any one of them without disturbing the other or making trouble in respect to settlement.

The contractors are required to carry all water and sewer connections 5 ft. inside of the curb line, for present or future use.

FIG. 11. FORMS FOR COUNTERFORTED WALL ON DOWNHILL SIDE OF STREET

FIG. 12. CURVED WALL OF CANTILEVER TYPE HOLDING UPHILL BANK AT RUBENS ST. THE BANK AT THIS POINT IS SLIDING GROUND

(Figs. 11 and 12. South 18th St. Improvement. Retaining-wall Construction).

IMPORTANT STREET IMPROVEMENTS

Besides these three regrade enterprises, three important street improvements of different character are being carried out. Two of them involve very elaborate reinforced-concrete retaining-wall construction in large amounts; the third is a street-grading project in connection with a grade-crossing elimination. The improvement of South 18th St. involves a price of about $90,000, the improvement of West Carson St. about $204,000, and the improvement of Second Ave., with elimination of the Try St. grade crossing, about $115,000.

A great amount of other street-improvement work has been constantly under way during the last year or two, in the form of grading, curbing and paving work of more ordinary character, involving no special technical features. This other work totals about $750,000, including work recently completed, work now in progress, and work soon to be begun. Thus the three improvements specially mentioned are by no means the largest item of cost in the city's street-improvement work, but they are singled out by their special importance to the city and their technical features.

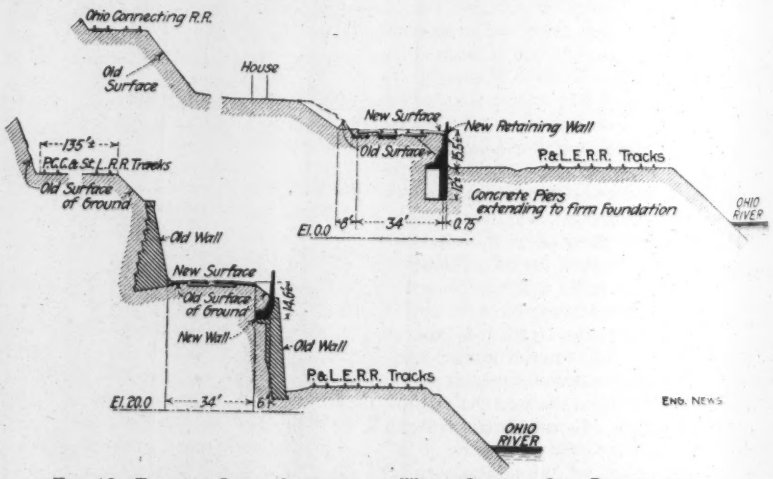


FIG. 13. TYPICAL CROSS-SECTIONS OF WEST CARSON ST., PITTSBURGH

IMPROVEMENT OF SOUTH 18TH ST.

South 18th St., a winding hillside street in the easterly portion of the South Side hills district, a main road of communication, was improved during the past year by widening, grade improving and paving. The length of the improvement is about 5000 ft. The widening and grading required the hillside on the upper side of the street and the bank of the roadway on the downhill side to be held by retaining walls totalling over 2000 ft. in length.

The maximum height of wall required was about 22 ft. (with 11-ft. base) for the cantilever type of wall, and 25 ft. (11-ft. 6-in. base) for the counterforted wall. A number of the walls, which at the level of the foot of the embankment did not reach stable foundation, are supported on pier footings going down to rock bottom. Some walls 20 ft. high rest on such pier foundations. Fig. 10 shows some typical wall sketches.

About half of the retaining walls in this improvement are of the reinforced-concrete cantilever type, and there was only one short section of counterforted wall. Gravity walls (also of concrete)

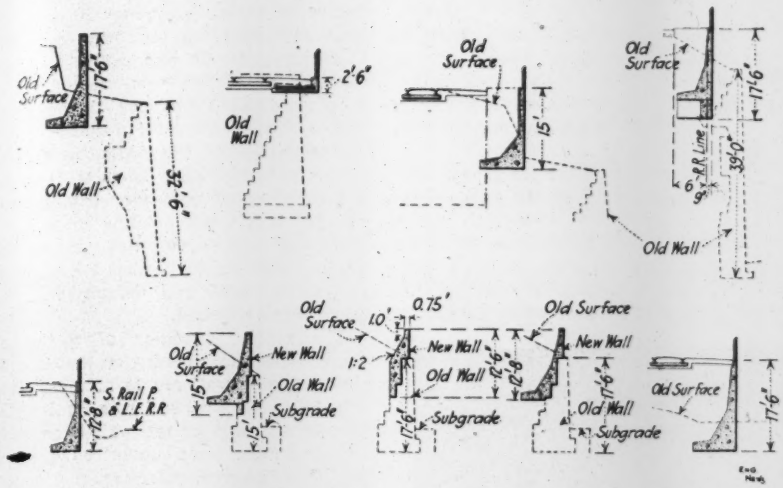


FIG. 14. SKETCH SECTIONS OF NEW RETAINING WALL, WEST CARSON ST.

were employed to a considerable extent, however, chiefly where the wall was of considerably variable height. Besides these three types of gravity, cantilever, and counterforted retaining wall, wooden cribbing was used at a few points for the support of the downhill side of the roadway, though the designers restricted this to the fewest possible locations. Such cribbing was made of unsurfaced squared hemlock timber, laid close on the face and tied to the back wall by headers. Both face wall and back wall extend up to the surface of the street; the cribbing was filled with dirt tamped in 6-in. layers.

The retaining-wall work is similar to that in the West Carson St. improvement. A few sections are given in Fig. 10. Some views of the work on South 18th St. are reproduced by Figs. 11 and 12.

The contract for the work was let on May 20, 1911, to M. O'Herron & Co. for $88,300. Of this amount, $30,170 was paid for retaining walls, covering 2063 lin.ft. of wall (1012 ft. reinforced-concrete wall, 1051 ft. of concrete gravity wall). The contract is expected to be entirely completed early this fall.

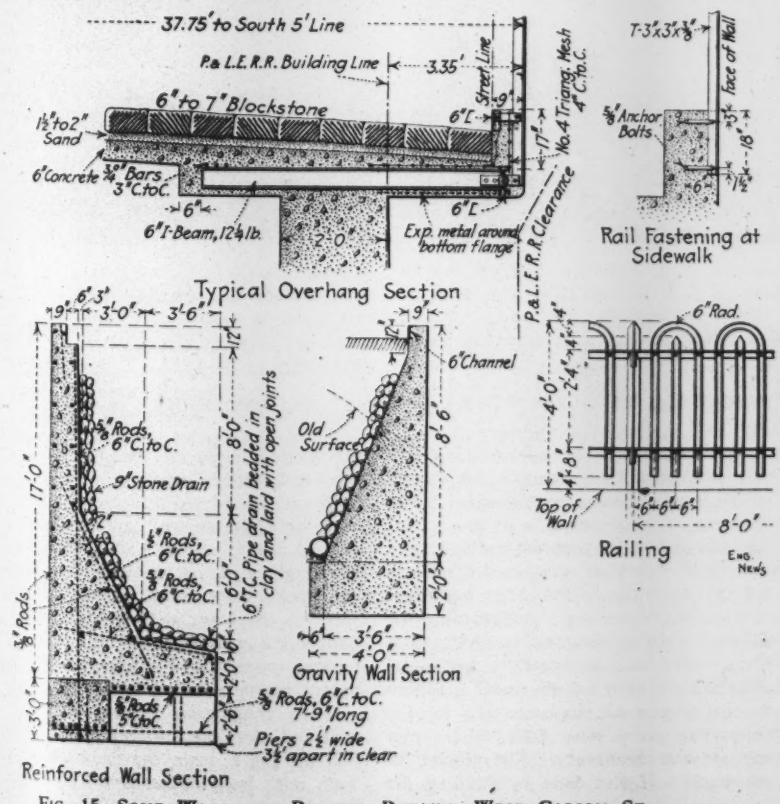

37.75' to South 5' Line
P. & L.E.R.R. Building Line
3.35'
Street Line
6" to 7" Blockstone
1½" to 2" Sand
6" Concrete
⅝" Bars 3" C. to C.
6" I-Beam, 12¼ lb.
6" L
Exp. metal around bottom flange
No. 4 Triang. Mesh 4" C. to C.
P. & L.E.R.R. Clearance
Typical Overhang Section
T-3"x3"x⅜"
face of Wall
⅝" Anchor Bolts
Rail Fastening at Sidewalk
6" Rad.
Top of Wall
Railing
6" Channel
Old Surface
⅝" Rods, 6" C. to C.
9" Stone Drain
½" Rods, 6" C. to C.
⅝" Rods, 6" C. to C.
6" T.C. Pipe drain bedded in clay and laid with open joints
Gravity Wall Section
⅝" Rods, 6" C. to C. 7'-9" long
Piers 2½' wide 3½' apart in clear
Reinforced Wall Section

FIG. 15. SOME WALL AND RAILING DETAILS, WEST CARSON ST.

WEST CARSON ST. IMPROVEMENT

One of the most important street improvements made in Pittsburgh in recent years is the widening, straightening, grading and paving of West Carson St., from Steuben St. to Chartiers Creek (city line). This street, running along the south bank of the Monongahela River, is the only practical means of highway communication between the city proper and the boroughs of Crafton, Ingram, Carnegie, McKees Rocks, and a portion of the 20th Ward, formerly Sheraden Borough. West Carson St. was originally a toll road owned by the Robinson & Chartiers Township Road Co., and was purchased by Allegheny County and dedicated to public use.

The street is about 1.2 miles in length and varies in width from 33 to 50 ft., with a double-track street railway. The only portion of the street which could be used by traffic was the paved part between the tracks. During high stages of water in the Ohio River certain sections of the street were flooded, thereby cutting off traffic.

On nearly the whole distance from the North Side Point Bridge to Chartiers Creek the street is hemmed in on the river side by the tracks of the Pittsburgh & Lake Erie Ry., lying at a lower level, and on the land side by the tracks of the Pittsburgh, Cincinnatti, Chicago & St. Louis Ry., lying 20 to 30 ft. above the street. Below the West End district the street had for some time been in specially bad condition. Insufficient and variable width, irregular profile with low points exposed to floods, and a very defective surface, made travel on the street uncomfortable and congested.

Improvement required a general widening and rectification of alignment where possible, together with improvement of grades and repaving. The grading and widening in combination required extensive construction of retaining-walls along the river face of the road to bring the existing retaining-wall of the P. & L. E. Ry. up to the street grade. It was possible to improve the alignment at some points, and to gain width at places where the streets were too narrow, by a number of exchanges of strips of land between the city and the Pittsburgh & Lake Erie Ry. This, however, made it necessary at some points to cantilever the street out over the railway tracks, a maximum of 5 ft.

The P. & L. E. retaining or facing wall is of concrete, gravity section, built eight to ten years ago. In general it extends little above the surface of rock, the street embankment above this point being sloped. It was necessary to either extend the railway wall to the new street

grade, or to build a separate retaining-wall above it. The latter course was followed at all points. The alignment is such that at some places the street retaining-wall is back of the railway wall, while at other points it is seated on top of the railway wall.

Thus the conditions governing the design and construction of the retaining-walls for the street improvement were extremely varied. On this account we illustrate the work herewith by two typical cross-sections of the street, Fig. 13, to show the relation of the street to the bordering railways, and by a collection of retaining-wall sections and details, Figs. 14 and 15.

The length of the improvement is 6555 ft., extending from Sawmill Run to Chartiers Creek. Throughout the regrading and construction work, street-car and roadway traffic had to be maintained, as there is no alternative route to the outlying districts reached by West Carson St. This made the work particularly complex and slow, considering that a retaining-wall had to be constructed along the full length of the street, involving 2064 lin.ft. of plain concrete wall and 4491 ft. of reinforced-concrete wall and overhanging work (of steel I-beams and concrete slab).

The contract for the West Carson St. work was let May 5, 1911, for the sum of $204,418.50. The work is expected to be completed by the end of 1912. Booth & Flinn, Ltd., is the contractor.

The nature and difficulties of the work will be appreciated from the above statements, in connection with the section sketches, Figs. 13 to 15, and the views of work in progress, Figs. 16 to 18. Retaining-wall construction was at all points the first item of work, except for the construction of a concrete-arch culvert at Cork's Run, about in the middle of the section under improvement. The sheeting on the inner side of the retaining-wall excavation was ordinarily braced against the rock or against the railway facing wall, though this latter expedient in one case succeeded in overturning the railway wall by splitting it apart on a plane which was apparently a horizontal construction joint of the wall. Within the excavation the separate pits for the supporting piers were built, where pier support was necessary. The placing of the wall itself was done by building the forms complete to the top, with reinforcing in place, in sections 20 to 40 ft. long, and concreting an entire section in one operation. In this work a mixer mounted on wheels was used, the materials teamed to it, and the concrete chuted directly into the form.

The design of the walls, as to distribution and placing of metal, will be self-explanatory from the cross-sections shown. It is worth pointing out that the cantilever type of wall was used on this improvement to the virtual exclusion of the counterforted wall, though heights of 20 ft. were required.

The special condition of service of these walls where resting on the old railway retaining-wall are to be noted (see Fig. 14). As a general rule the foundation of all parts of the wall is on rock, except for the front support on the wall, and it is believed, therefore, that a normal distribution of foundation pressures is obtained. The pier supports, used in all cases where rock was not found at the footing level, are like those used in the South 18th St. work.

In normal service these retaining-walls carry only the level fill and concentration of load due to wagon traffic. During the construction period, however, the street-car tracks were frequently shifted over close to the wall, and under these conditions the wall was exposed to an abnormal concentrated surcharge. No apparent injury resulted from this.

After completion of any section of wall and after the dry stone backing was laid up (as a drain for the back of the wall, with longitudinal drain pipes near

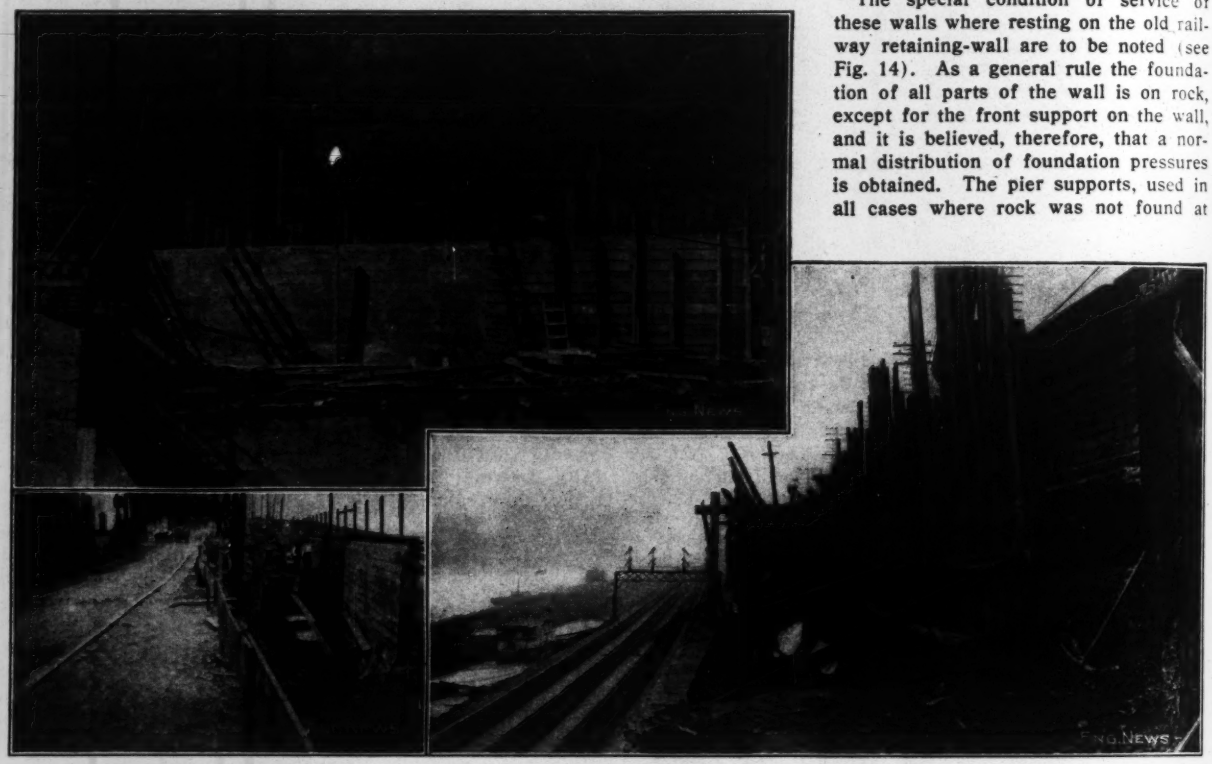


FIG. 16. TYPICAL PORTION, SEEN FROM THE P. & L. E. RY. TRACKS
(P. & L. E. wall below, new city wall above, stone wall of P. C. C. & St. L. Ry. above on far side of West Carson St.)

FIG. 17. SECTION OF CANTILEVER TYPE OF WALL, WEST CARSON ST. IMPROVEMENT
(Dry stone packing back of wall just begun).

FIG. 18. EXCAVATION AND SHEETING FOR WEST CARSON ST. WALL
(Forms for wall in background, diverging from railway wall. Sheeting on street side of retaining-wall trench in foreground, showing usual bracing against railway wall).

FIGS. 16-18. RETAINING-WALL WORK ON WEST CARSON ST. IMPROVEMENT

the base of the wall), the retaining-wall was backfilled and the river half of the roadway graded to the new elevation, to receive the trolley tracks so that the southerly half of the street could be cleared and graded. The change in street profile, while requiring cutting or filling at nearly all points, did not involve any deep cuts or fills. It thus proved possible to keep the road open for both wagon and street-car traffic throughout, though with great inconvenience to traffic at times.

No retaining-wall construction was required on the land side of the street. Here the embankment of the P., C., C. & St. L. Ry. is on practically the whole length of the street held by an old cut-stone retaining-wall, still in excellent condition.

The only street substructures involved in this street improvement were the wire ducts (built against the back of the wall and in part built into the wall), a new 16-in. sewer, and a new 20-in. cast-iron water main which was laid in the fill 5 ft. back of the new retaining-wall as a possible future supply main for the outlying boroughs.

The retaining-wall was topped off by a structural-steel railing (see Fig. 15). The sidewalk for pedestrian traffic is not continuous along the north side of the street, on account of insufficient width in places even after the widening. The same type of railing is used along the sidewalk and where the walk is omitted.

Try St. Grade-crossing Elimination

Work is in progress for the elimination of a very troublesome and dangerous grade-crossing on the main line of the P., C., C. & St. L. Ry., where it passes out of its Pittsburgh tunnel to the bridge over the Monongahela River and crosses Second Ave. An important street-car line runs along Second Ave., this street being the river-bank road to points up the Monongahela River. Joint action by the railway company and the city was secured, after negotiations complicated by the fact that an old main sewer extending along the railway required rebuilding to give necessary increased capacity and to permit of building the new abutments and retaining-walls over it.

The change at the crossing of the railway and Second Ave. involved a raising of the railway grade by 5 ft. 9 in. and a lowering of the street grade by 10 ft. The profile of the railroad is raised for the entire distance from a station just north of Third Ave. to the bridge, about 1000 ft. south, with new bridge-crossings over Second Ave., First Ave., and Water St. The approach span of the bridge was also raised slightly. The development of the railway roadbed to permit laying additional tracks in the future called for the construction of a retaining-wall along either side of the right-of-way between Water St. and Second Ave., so that the whole width of the right-of-way will in future be usable.

The change of grade of Second Ave. extends about a quarter mile east of the railway crossing with general improvement of the street profile. The street is also widened for a further distance of 800 ft. Grading of the street and construction of the railway retaining-walls is now going on, but the entire improvement will not be completed until in the early part of 1913. Profiles of the street and railway are shown in Fig. 19.

The Fifth Ave. and Try St. main sewer, which drains the so called Try St. sewerage basin, comprising about 370 acres of the city area, is intimately connected with the grade-crossing improvement. This sewer, passing down Fifth Ave. and then along the railway right-of-way to the Monongahela River, was built in 1869. It was recently found to be in very bad condition, the invert being all eroded away and the arch in many places broken

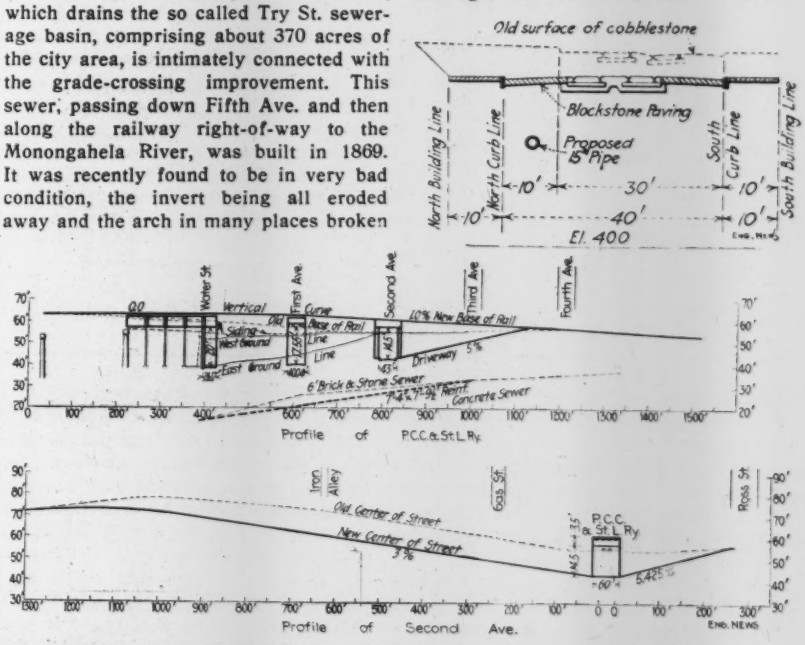


FIG. 19. RAILWAY AND STREET PROFILES, TRY ST. GRADE-CROSSING ELIMINATION

and even so much disintegrated as to virtually hang in sheets. The brickwork was in such condition as to make repairs impossible, and in any case the capacity of the sewer was insufficient. On June 9, 1911, a contract was let to M. O'Herron & Co. for the construction of 3987 ft. of sewer, partly concrete and partly brick, ranging in size from 8-ft. circular to a basket-handle section 5 ft. 8 in. by 5 ft. 11½ in., for the sum of $115,476, to replace the existing Fifth Ave. sewer. The construction work proved very difficult, as the new sewer was close alongside the old one in many places and the trench was threatened by the bad condition of the old sewer. The part of the sewer which passed along the railway right-of-way was in much better condition, but the improvement of the sewerage district required its replacement by a larger section. This portion of the work was under an agreement taken over by the railway company, except that the city pays a share of the cost corresponding to the increase in capacity, determined as about 15%. This work is being done by the Cranford Construction Co., and will probably be completed by fall. The new sewer has been constructed at the Second Ave. crossing and east of this point; there is still lacking a connection between the Fifth Ave. portion and the railway portion of the sewer, which the city will probably soon put under contract, and the new outfall.

The railway retaining-wall work is being built by the John F. Casey Co. This work includes the construction of the abutment for the plate-girder crossings over the three streets and the retaining-walls between streets. The Fort Pitt Bridge Works will furnish the superstructure of the crossings.

The first item of work was construction of the new sewer under Second Ave. and south thereof. Only the westerly part of this was in rock, the surface of rock dipping sharply to the south. Piles were driven in the sewer trench as a foundation in the earth portion. The flow of the old sewer, parallel to and just west of the new sewer, was then diverted to an opening in the new sewer south of Second Ave., leaving the lower section of the old sewer to be wrecked, this part coming directly under the new railway retaining-wall.

Meantime the railway had been raised to the new grade by jacking and filling, with pile trestle support over the locations of the street-crossing abutments and on the large part south of Second Ave. The abutments of the Second Ave. bridge were built in trenches under the railway, and excavation was begun for the retaining-walls south of Second Ave. The wall construction is now in progress.

The contractor's plant includes two cableways, one longitudinally over each

TABLE OF UNIT-PRICES OF IMPORTANT STREET-IMPROVEMENT WORK IN PITTSBURGH

NORTH SIDE FLOOD-FILL

(Contractors, Booth & Flinn, Ltd.)

First Contract (east to Grantham St.)

	Est. Quantities	Unit price
Embankment	62,500 cu.yd.	.35
Blockstone pavement	16,000 sq. yd.	2.82
Creosoted wood block pavement	5,900 sq.yd.	3.10
Vitrified repressed brick pavement	11,100 sq.yd.	1.80
Concrete sidewalks	139,000 sq.ft.	.16
Total price		$157,512.70

Second Contract (east from Grantham St.)

Embankment	21,000 cu.yd.	$ .25
Blockstone pavement	4,100 sq.yd.	2.80
Vitrified repressed brick pavement	850 sq.yd.	2.00
Sandstone curbing	3,000 lin.ft.	.70
Concrete sidewalks	26,500 sq.ft.	.15
Total price		$29,380.00
Total price, both contracts		$186,892.70

WEST END FLOOD-FILL

(Contractor, Jas. H. McQuade)

Embankment	35,500 cu.yd.	.35
Blockstone pavement	5,425 sq.yd.	2.80
Asphalt block pavement	3,385 sq.yd.	2.35
Protected concrete curb	8,200 lin.ft.	.90
Concrete sidewalks	80,000 sq.ft.	.14
Lumber for misc. structures	10 M. ft. B.M.	75.00
48" concrete sewer	3,750 lin.ft.	10.14
52" concrete sewer	725 lin.ft.	20.04
Constructing sewer siphon (Lump Sum)		2100.00
Brick catch basins	32	65.00
Total price		$137,015.10

HUMP CUT

(Contractors, Booth & Flinn, Ltd.)

Excavation	143,000 cu.yd.	$3.00
Blockstone pavement	13,700 sq.yd.	3.75
Creosoted wood block pavements	10,700 sq.yd.	4.00
Vitrified repressed brick pavement	4,600 sq.yd.	3.00
Protected concrete curb	20,200 lin.ft.	1.00
Concrete sidewalk	175,000 sq.ft.	.20
Lumber for temporary roadways, sidewalks and bridges	150 M. ft. B.M.	80.00
Total price		$671,450.00

IMPROVEMENT OF SOUTH 18TH STREET

(Contractor, M. O'Herron Co.)

Grading	18,800 cu.yd.	.35
Blockstone pavement Class A laid on concrete base	11,700 sq.yd.	2.95
Sandstone curbing	9,660 lin.ft.	.70
Plain concrete in walls	575 cu.yd.	7.00
Reinforced concrete in walls	1,750 cu.yd.	7.50
Steel reinforcement	138,000 lb.	.06
Excavation for walls	3,900 cu.yd.	.60
Total price		$88,300.00

IMPROVEMENT OF WEST CARSON STREET

(Contractor, Booth & Flinn, Ltd.)

Grading	33,000 cu.yd.	.60
Sandstone curbing	7,600 lin.ft.	.80
Blockstone pavement Class A on concrete base	15,600 sq.yd.	3.55
Plain concrete in walls and foundations	1,750 cu.yd.	8.00
Reinforced concrete in walls	5,780 cu.yd.	8.00
Excavation for retaining-walls	10,900 cu.yd.	1.00
Structural steel fence	7,250 lin.ft.	2.00
Steel reinforcement in walls	292,000 lb.	.04
Cantilever sidewalk construction	360 lin.ft.	5.00
Cantilever roadway construction	224 lin.ft.	4.00
Total price		$204,418.50

retaining-wall, and a short piece of track transverse to the cableways from a concrete-mixing plant in a vacant area to one side of the right-of-way. The concrete is run down the track in bucket cars, stopped under the proper cableway, and the bucket hoisted and run to the place of working.

Where the east retaining-wall comes over the old sewer, the latter is torn out completely and the space filled with concrete from sound bottom to the base of the wall.

OTHER IMPROVEMENTS

The main sewers of a number of the individual sewer basins of the Pittsburgh area require reconstruction for increased capacity due to the building up of the drainage area and gradual elimination of surface runoff. The several basins are being taken up for study consecutively. Besides the Try St. basin (above mentioned), the 33d St. basin and the Negley Run basin are now being improved. In both cases the existing main sewers are in good physical condition, but either wholly or at some points are of inadequate capacity, in many cases because of irregular profile.

The 33d St. replacement sewer, soon to be advertised, will be a length of about 3000 ft. of 8-ft. brick or concrete sewer, to run parallel to an existing 6-ft. sewer, along and crossing the Pennsylvania R.R. right-of-way near Shadyside Station. The two sewers at the lower end will discharge into an existing 7-ft. sewer of steeper grade and of capacity approximately equal to the two sewers combined.

The Negley Run sewer, extending along Washington Boulevard under the new Larimer Ave. arch bridge to an 11-ft. intercepting sewer at the Allegheny River which carries the discharge to a point below the lock and dam nearby, is being supplemented by a basket-handle sewer, 8 ft. 3 in. by 8 ft. 6 in., of concrete. The existing sewer is of 9-ft. circular section. Construction work is in progress. The work throughout is in shallow cover. The new sewer is about 8300 ft. long. The area drained is 2600 acres, with population of 52,000 ultimate. The existing and the new sewer combined will be ample for the full ultimate development of this area. The contractor is J. B. Sheets & Co., and the price is $159,000.

All street and bridge work in Pittsburgh is under charge of the Bureau of Construction of the Department of Public Works. Jos. G. Armstrong is Director of the Department of Public Works, and N. S. Sprague is Superintendent of the Bureau of Construction. The Division Engineers of the bureau are: T. M. Reed, in charge of the Division of Street Improvements; I. C. Palmer, in charge of the Division of Sewer Extensions; C. M. Reppert, in charge of the Division of Design, and T. J. Wilkerson, in charge of the Division of Bridges.

New Improvements in Pittsburgh are to be decided by a referendum vote on a new bond issue at the election in November. The total money involved will be over $8,000,000. The chief items which have been approved by a Committee of the City Council are as follows: For water meters, extension of pipe lines, etc., $1,620,000; grade crossing eliminations, at Homewood, and at 33d St. and Liberty Ave., $420,000; for new market houses, $450,000; for public comfort stations and drinking fountains, $90,000; for dock improvements, including a seawall along the river front, $900,000; for extension of the underground electric system and installation of a new fire-alarm station, $240,000; for ground for extending the site of the new City Hall, $1,250,000; for street improvements and damages (Ohio St., Morewood Ave., Arlington Ave., Grandview road), $930,000; for park lands, $360,000; for south approach to Point Bridge, additional, $180,000; for funding floating debts, $990,000; for miscellaneous improvements, $930,000.

A Flood in the Caloosahatchee River Valley, Florida

By W. W. Fineren*

There has been considerable discussion of late by engineers and laymen regarding the drainage of the Everglades of Florida, some of which has found place in the pages of the ENGINEERING NEWS. In view of these discussions it is perhaps interesting to note the result of a recent flood in the Caloosahatchee River valley, which, although it has no direct bearing upon the drainage of the Everglades, is, nevertheless, worthy of attention and study.

There is a heavy fall or slope, and consequently a swift current, from Lake Okeechobee to Fort Thompson on the river. (See accompanying sketch-map and profiles.) The fall from Fort Thompson to the Gulf of Mexico is negligible. The river is very narrow and extremely crooked and tortuous. The elevation of mean low water in the lake, obtained from latest surveys, is 20.6 ft. above mean low tide in the Gulf, and the elevation of the mean low-water surface in the river at Fort Thompson is approximately 1.5 ft. above the same datum plane in the Gulf. It is readily seen that excess water from the lake coming down the narrow and steep channel will quickly flood the lower valley below Fort Thompson, and such has been found true on several occasions.

Originally the Caloosahatchee River had its beginning in the glade lands and small lakes west of Lake Okeechobee, but had no direct connection with Lake Okeechobee. Under contract with the Trustees of the Internal Improvement Fund of the State of Florida, Hamilton Disston (The Atlantic & Gulf Coast Canal & Okeechobee Land Co.) began in 1881 and completed about 1884 a canal connecting Lake Okeechobee and the Caloosahatchee River at Fort Thompson.

After the completion of this canal floods in the lower valley became frequent and destructive to citrus fruits and farm crops, and the owners sought relief, as seen from the following extract of a report two years later by Col. James M.

*Junior U. S. Engineer, Federal Building, Tampa, Fla.

Kreamer, chief engineer of the Okeechobee Drainage Co.:

Further drainage through the Caloosahatchee is barred from the fact that the capacity of the upper Caloosahatchee River at Fort Thompson is fully taxed at present to carry the water reaching that point via the drainage canals already constructed; and the residents of that region are petitioning the internal improvement board to provide relief during and subsequent to the rainy season by closing the canal at a point just west of Lake Hicpochee.

These appeals of the people were not heeded and later a private fund was subscribed and an earth dam was constructed across the canal at the west end of Lake Hicpochee, to stop the flood waters of Okeechobee. This condition did not suit the many fishermen who made a living by fishing in the lake and the earth dam was later blown up by unknown parties and remains so today. During April, 1907, the writer made an investigation of the river with respect to navigation and found much agitation pertaining to the rebuilding of the dam, but such has never been undertaken.

The opposition of the land owners to the drainage of the lake through the Caloosahatchee River is reflected in the following extract from the report of J. O. Wright, Supervising Drainage Engineer, Department of Agriculture, made under date of Feb. 25, 1909:

There is grave apprehension that any enlargement of the upper portion of the Caloosahatchee will cause it to overflow its banks along its lower course and damage the citrus groves. Such will not be the case when Lake Okeechobee is lowered and the discharge brought under control. There will not be as much water brought down this channel as is now carried by it in time of high water. The flow is to be regulated by locks at the upper end, and only as much water permitted to enter the canal as the stream can carry without damage to the property along its course.

In June, 1912, very heavy and continuous rains were experienced in this section and throughout the state generally. At this time the water surface in the lake was below normal. During the middle of March the writer made an examination of the water levels in the river and lake and reported as follows:

I learned from different parties that the water had been falling steadily for four or five months. I could see by the banks that it had fallen from one to one and a half feet in the Caloosahatchee River. According to my levels the water was 1.22 ft. lower than mean low water stage at the lake.

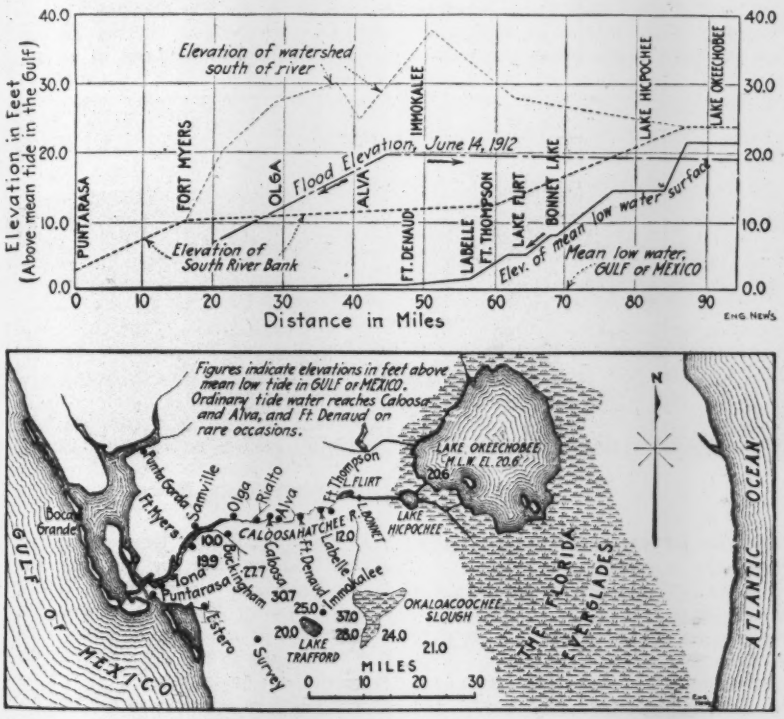
Navigation in the Caloosahatchee River, above Labelle, is endangered by low water. Two feet is all that can be carried at this time.

From statements of fishermen it appears that the water continued to fall until June, at which time it could not have been higher in the lake than the level found in March, which was 19.38 ft., with very little water flowing into the river.

The rain began at Fort Myers on Tuesday afternoon, June 4, and it rained fairly hard and steady till Sunday afternoon, June 9. Some workmen were constructing a cistern, which was nearly completed at this time, and abandoned work on account of the rain. At the end of the five days it was found that there was 17.5 in. of water in the cistern, the cistern not being connected in any way to a water-supply. In the report of J. O. Wright, referred to above, the maximum rainfall for two consecutive summer months in this vicinity is given, for different towns, from 20 to 27.95 in., but here is a record of 17.5 in. in five days.

It will be noted from the accompanying map and profile that the south shore of the river from Fort Myers to Fort Thompson, although low, gradually rises as it leaves the river, culminating in a height of 37.7 ft. at Immokalee. The water from this area, as well as that from high ground on the north shore of the river, found its way to the river in the vicinity of Labelle in such volume that the narrow and crooked stream was unable to carry it off, and the water rose, on June 14, to such height as to exceed the then existing elevation of the lake (not over 19.38 ft.) and the people had the opportunity of seeing the flood waters of the Caloosahatchee run up river, overcoming a slope of 0.86 ft. to the mile for a distance of over 20 miles. The height of the water at Labelle has not been determined by instrument, but was estimated to be from 7 to 8 ft. above the ground surface, where there is a bench mark showing an elevation of 12. A positive and swift up-river current was observed at the west end of Lake Hicpochee and a very slight up-river current noted in the three-mile canal at the entrance to Lake Okeechobee.

After years of energy spent in an endeavor to fortify the Caloosahatchee Valley against the dreaded Lake Okeechobee, it is not without discouragement to the fruit and truck growers and not without interest to the engineer to see the waters of the river valley push up hill for over 20 miles, overcome a head of 19 ft. and take possession of the yet uncontrolled lake.



MAP AND PROFILE OF CALOOSAHATCHIE RIVER, FLORIDA, AND FLOOD CURVE OF JUNE 14, 1912

An international building trades exhibition is to be held at Leipzig, Germany, next summer. It is expected that the exhibition will open early in May and will continue until the end of October. The exhibition is under the patronage of the King of Saxony and is to cover everything in connection with the construction and equipment of buildings. Special supplementary exhibitions are to be arranged devoted to subsidiary branches, such as lighting, glass, frescoed rooms, tapestried rooms, etc. A special department of science and art has been established in which, in a special building, exhibitions will be grouped by subjects and not by exhibitors.

This exhibition will form an additional attraction for the Members of the American Society of Mechanical Engineers who are to hold their meeting at Leipzig by invitation of the German Society of Engineers next June. Dr. E. Probst, of Berlin, Germany, who recently came to the United States to attend the International Congress for Testing Materials, will act during his stay in this country as the American representative of the Leipzig Exhibition, and may be addressed until Oct. 25 in care of the American Express Co., New York City.

FIELD AND OFFICE

Notes on a Costly Brazilian Railway Line

By A. E. Hess*

On Sept. 7, 1912, the last section of the Madeira & Mamoré Ry. was inaugurated or formally opened for traffic. This section extends from Abuna (km. 220) to Guajara-Merim (km. 364). The date selected for the consummation of this costly enterprise is one of the three great Brazilian holidays—the thirtieth anniversary of the political separation of Brazil from Portugal. The happy event was witnessed by many Brazilian government officials, and by several representatives of the Pan-American Union, and by one of the surviving engineers of the Collins expedition of 1878. The Baldwin locomotive "Colonel Church," taken to Brazil in 1878, was used to draw the official train.

As this work is but little known in this country the following notes are submitted.

Why the Railway is Being Built

Three reasons, geological, political and commercial, lie behind the building of the Estrada de Ferro Madeira e Mamoré.

Some nineteen or twenty granite ridges or dikes cross the valley of the Rios Madeira and Mamoré in a distance of a little more than 200 miles, forming at each crossing dangerous rapids or cachoeiras, a bar to all navigation except small boats or batelaos of from 2 to 10 tons.

These small crafts are propelled by from 8 to 16 paddlers. Their progress is painfully slow. They pass the less dangerous rapids by using poles and hooks, and sometimes ropes, along the banks of the river. These navigators pass the more dangerous rapids, where there is perhaps a fall of several meters, by the primitive and laborious method of carrying their goods on their heads and by dragging or skidding their boats overland, sometimes for a half kilometer. I myself can vouch, from experience, for the danger and toil involved in this method of navigation.

The progress of a batelao down stream is usually about four or five times as fast as when going up. The easier rapids are "shot" or "run" with frightful velocity and much danger. The average life of a boatman on these rivers is taken to be only four years, owing to the dangerous navigation and the pestilential climate.

The political reasons for building the railway arise from the difficulty, or perhaps the impossibility, of marking political boundaries permanently, or of defining these boundaries in treaties so that both states shall understand the same thing in the same way. The Territory of Acre (pronounced "Ahker") a vast unexplored, uninhabited virgin wilderness lying about the Rio Purus, and between the Madeira and Rio Solimoes, was held at least in part by both Bolivia and Peru for many years. Each claimed the entire territory. Brazil was called in as the arbitrator, and by the treaty of Petroplis, in 1905, settled the dispute without loss to Brazil. The bulk of the disputed territory was given to Bolivia, and then taken from Bolivia by Brazil in consideration of services rendered, and of the construction of a railway in Brazil, to pass the dangerous rapids, and be an outlet for Bolivian trade to the Atlantic coast. This railway was to be on the Brazilian side of the Rio Mamoré where that stream is the boundary between the two states. It is to be noted that this railway will serve the hinterland of Brazil quite as well as it will Bolivia, and that its tariff will be fixed not by Bolivia but by Brazil. Bolivia also received two million pounds sterling from Brazil to be expended in railway development in the former country so as to bring traffic to the railway. As a further political reason it is to be said that this railway, lying as it does along Brazil's remote frontier, has great strategic value for military purposes.

Commercially its value is unquestioned, as it connects the head of steamboat navigation on the Rio Madeira with the side door of Bolivia, forming an outlet for the natural products of all that vast region of Bolivia lying east of the Andes, and an inlet for European and North American merchandise. During the dry season, May to November, the Rio Madeira is navigable by steamers of 8 ft. draft, and in the wet season by the largest ocean-going vessels, as far up as the northern terminus of the railway, Porto Velho. It is a line of railway that will never be paralleled, and can have no competition.

View of Port Velho, Brazil, the Lower

Population

This region has no population. It is a wild stark wilderness, whose bounds are not known by man. Except a few kilometers at the Porto Velho end in the state of Amazonas, the line lies in the Estado de Matto Grosso; the latter means virgin forest or big trees. Matto Grosso is as large as that part of the United States lying east of the Mississippi River from the Canadian boundary down to the southern line of Kentucky, and north of the southern boundary of Kentucky and Virginia.

Its entire population (157,000) is not greater than one-half that of Luzerne

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County, Pennsylvania. This population is in the southeast corner of Matto Grosso, which is there penetrated for 50 miles by a railway from the Atlantic coast. The nearest neighbor railway is 800 miles away off to the southwest beyond the crest of the Andes Mountains at La Paz, Bolivia. Try to conceive of that quarter of the United States above noted, having 50 miles of railway near Norfolk, Va., and 200 miles more out about Fond du Lac, Wis.—between lies a desert of savage unexplored wilderness, mostly an impenetrable jungle, not surpassed by Africa.

Porto Velho (old port) is an American town, artificial, and machine made, after a blueprint plan. Population, say, 500, all aliens, and all men. No man there is at home; he is doing his contract time. This is true in effect as to the Brazilian government (fiscal) engineers.

Santo Antonio is a native town of, say, 1200; disgustingly dirty; at times under quarantine for yellow fever. It is or has been the shipping port of the Bolivian mercantile house of Suarez Bros., who claim to have netted two million pounds sterling in the rubber trade in 1910.

Villa Murtinho has a population of 57, and is opposite Villa Bella, in Bolivia, at the mouth of the Rio Beni. The population of the latter place will not exceed 300.

Guajara-Merim is a town of 13 houses in Bolivia opposite the south end of the line; in other words, 364 km. from Porto Velho.

Cipherino Justianha, a trader, is the governor of the town, but Donna Justiad, a widow, owning mossas or peons, is the chief person. She also owns a Singer sewing machine, and she stitched a small American flag for the first party of engineers who reached that end of the line. This machine cost in her town 300 Bolivianas, or about $120.

Besides the population above enumerated, there are in the 364 km. perhaps two dozen palm-thatched baracoes scattered along the banks of the Madeira and Mamoré rivers, with very small patches of cleared land and a few stalks of bananas, and in one case I saw a little Indian corn.

Indian? There are no Indians, tales of travelers, and the early adventurers to the contrary notwithstanding. In the four years this line has been building, it is doubtful if more than a total of a hundred different Indians have been seen. I have seen four. No man has been killed by them nor have they been injured by the white man, though thousands of rounds of ammunition has been furnished the survey parties and the construction camps.

Game in the forest and fish in the rivers is abundant; but as for food products from the soil, there is not enough produced to feed forty men, and the railway company has had as high as 5000 men on the work at one time.

Topography

Speaking generally, this country would be classed as lowlands. The elevation of Porto Velho above tide is unknown, but is likely about 300 ft. above the mouth of the Amazon, 1700 miles away. The entire fall in the river from Guajara-Merim to Porto Velho, as measured by accurate levels, is only 61.4 m. in a distance of 364 km. by the line; and this, including all the rapids, is a fall of only 200 ft. in 225 miles. There is, of course, some swampy land, but the swamps are not impassable and are swamps only in the rainy seasons. The surface is generally flat or gently rolling, varying as much as 15 to 30 m. between two streams, and the ridge between them.

Taking the assumed elevation of Porto Velho as 96 m., the highest point on the line is near the Bananeira Falls, where the line reaches an elevation of 171 m. At only two points along the line, Tres Irmaos, and Paca Novo, can higher ground be seen. From these points ranges of hills apparently 600 to 800 ft. high are seen, at a distance of half a dozen miles. These hills have not been explored.

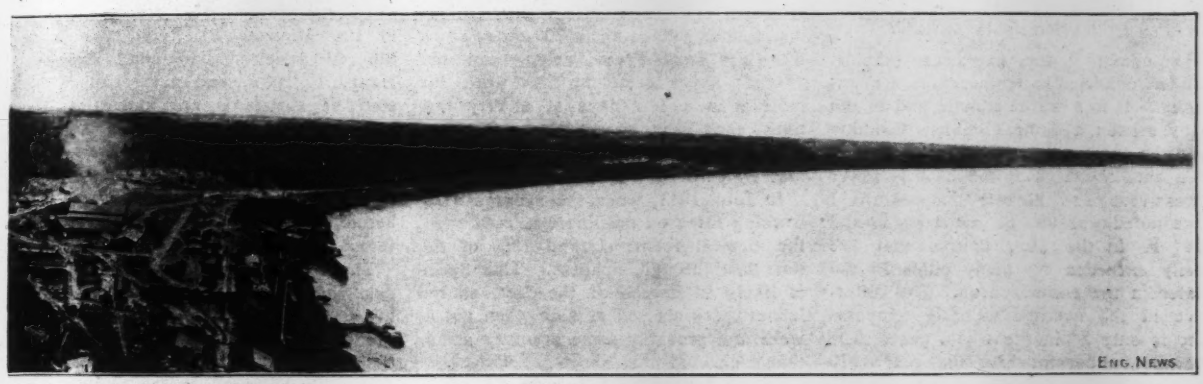
There are neither roads nor trails. All travel has been by batelaos on the rivers and their tributaries.

There are no grade crossings of the railway since there are no roads. The dense forest is everywhere. The poet who sighed "Oh for a home in some vast wilderness, some boundless contiguity of shade," could have been accommodated a thousand times here without making any sensible impression on the vast resources of the region.

The names and species of the forest trees are unknown and unclassified. Brazilero and Bolivian boatmen who know the rivers and the forest best never agree in their names for trees, and mostly they know no names. I do know one tree, the Castanho, which produces "nigger toes" or Brazil nuts. I can also recognize two or three kinds of palm trees. All trees grow very tall, an average of, say, 80 to 120 ft. and up to 150 and 175 ft. When a clearing is made, isolated trees left standing for shade are found to be dangerous, as they are not deeply nor firmly rooted, and a little wind turns them over.. Some of the trees along the edge of the right-of-way (110 ft. wide) clearing die during the dry season from the heat and lack of shade.

The forest is a dense jungle, impenetrable except by using machetes to make a "trocha," and is always cool, damp and shady. So perfect is this covering of verdure that the moisture of the ground is retained through the dry season, from May to November, sufficient to keep all vegetation in a flourishing condition.

Most of the trees are perennial, but some are deciduous. There are no conifers, only palms and hardwood, very hard wood, too, but with a lifetime, when cut into timber, that is measured by months and not by years. We find this especially true in all timbers used for bridges and railway ties. Doubtless much of the timber may be very valuable for cabinet work, and for the interior of houses. All of our desks, tables and cases are made of native cedar, which is



Terminus of the Madeira & Mamore Ry.

a harder wood than our North American cedar, has a beautiful grain, and takes a very fine finish. The railway company pays 1120 milreis per acre for clearing land, or about $360. There are no trees comparable to the big timber of California and Oregon. Very few trees here have a diameter greater than 2 m. (6.5 ft.).

Learned men from the rich universities of the North come to this "neck of woods." The railway company shelters, feeds and transports them. They bag butterflies, differentiate the age, sex, and habitat of ants; discover new bugs, bats and other vermin. Observations are made for terrestrial magnetism, and the variation of the declination of the magnetic needle has been precisely determined at many points. And the world is satisfied to read their wise words, and to treasure their exhaustive reports in million-dollar libraries. But I am unable to learn that any accurate examination of soil, minerals, trees, and lumber products has ever been made.

Climate and Health

The climate is very nice; very reliable. Sudden changes in temperature are unknown. It is a warm climate and in the rainy season a damp climate. Clothing mildews and leather goods are soon covered with mold. But the heat is never excessive. The highest temperature I have noted was 98° F. in the shade and 114° F. in the sun, figures that are easily exceeded by many cities in the States in the warm season. The difference in the average monthly temperature is only 5° in the whole year. The average temperature for the year 1910 at Porto Velho was 83° F. and for the year 1911 it was 83.5° F. In comparison it may be noted that in India the average annual temperature is reported at Bombay as 81° F., Calcutta 82° F., Delhi 77° F. But these cities have a much greater range of temperature than has the Amazon valley.

The early morning here is always very pleasant; suggests a May morning at home. About 10 a.m. it is warm; at 3 p.m. it is warmer, and about an hour before sunset it begins growing cooler. The nights are cool, and I have never lost an hour's sleep at night from heat. Mosquitoes and piums are abundant and active, but they are carefully excluded from the white men's sleeping quarters by mosquito netting. Even hammocks are furnished with mosquito bars.

This country is not healthy, though the west coast of Africa enjoys a worse reputation. I quote from a report of Dr. Martin, Fiscal (government) Engineer, for the year 1910:

> The sanitary conditions on the upper Rio Madeira have always been discouraging. Sometimes the malaria appears with such violence that the use of quinine, which in other malarial places is an infallible treatment to extinguish it, is almost inefficacious and does not give the desired result. These strong manifestations of the malaria fever appear specially during the low-water season.
>
> Besides the malaria which in such a merciless way pursues those who, forced by necessity, come to these regions, procuring better paid services, the beriberi, still more dreadful, prevails under frightful and fierce symptoms.
>
> This burdens still more the duties of the company. I believe that in no other part of the world a railroad has been built under the same conditions; fortunately the company did not lose its courage in spite of all the obstacles and felt strong against all natural elements.

The fiscal engineer quoted above does not tell us the fact that Manaos always has yellow fever, and that all the supply boats run between Manaos and Porto Velho; and that these boats frequently bring the fever up the river. Thanks to our able corps of Panama-trained medicos the fever has never gone above Santo Antonio except in a few cases which were promptly treated.

From the beginning of the work in 1907 until January, 1911, the fiscal (government) engineer's office was at Humytha, a small village some 200 miles down the river from Porto Velho, and the "fiscal" never came up the work for more than a few days at a very few times each year, so great was the Brazileiro officials' respect for "the pestilence that stalketh by night."

In July, 1911, when the average daily working force on the line was 5000 men, the medical report showed 13% of the time lost through sickness. This figure is likely in excess of the fact, as the laborers are classed as sick when not at work and probably some are lazy rather than sick.

In the past year 3 doctors out of 15 on the work have died, and 2 have been invalided home. Out of 70 civil engineers only one died and a half dozen have been invalided home.

Service here for white men is under contract for one year on the work, and three months' vacation in the States with half pay.

The present organization represents the survival of the fittest. Many are veterans of two and three years' service, and some there are who began at the beginning in June, 1907.

For a tropical country the rainfall here is not excessive. During the dry season of 1910, the total rainfall for May, June, July and August was only 5.17 in., and for the remainder of the year the total was 69.52 in. For the year 1911 the figures were 3.85 in., and 84.17 in., respectively. The greatest one-day rainfall shown by our records was 5.64 in., and the greatest precipitation for one month was 24.50 in., in January, 1903.

The Rio Madeira, fed by tributaries having their origin between and around the snow-clad peaks, Llampu and Illimani (21,000 ft. above tide) in the Bolivian Cordilleres (Andes), has an annual rise and fall, as has the Nile, quite independent of local rains. This rise begins in November as the sun approaches the tropic of Capricorn, and reaches a maximum of 45 ft. above low water, about the end of February. By the middle of July it has subsided again to the low-water stage.

The Railway

The construction of this line was begun in 1878 by Collins Bros., contractors, of Philadelphia, Penn. They made a splendid start, but were compelled by financial reasons to abandon the work after losing by sickness and accident about one-fourth of all the men they brought from the States.

The present work was begun in July, 1907, by May, Jekyll & Randolph, contractors for the Madeira Mamoré Railway Co., incorporated under the laws of the State of Maine. The work is done for the government of Brazil, which holds the purse strings, and its fiscal engineer, Geraldo Rocha, is now resident of Porto Velho. He reports directly to the Minister of Public Works at Rio de Janeiro. The chief engineer, Henry F. Dose, and nearly all of his staff of assistants are natives of the States, as are the contractors, superintendents, foremen and bookkeepers. The work that is being done requires men of unwavering faith, stern courage, and heroic endurance. These men have been found.

The line is a meter (3 ft. 3⅜ in.) gage, having a roadbed width of 4.2 m. in cuts and 4 m. in fills. The maximum grade is 1%, and the sharpest curve is 6° for a chord of 20 m., or about equivalent to a 9° curve in the States. The grades are generally undulating, as the line crosses all the lateral drainage of the right bank of the Rios Madeira and Mamoré. There are many concrete box culverts; many steel-bridge spans of from 10 to 44 m. and one span of 84 m. crossing the Jaci Paraná on kilometer 90. The deepest cuts are 35 to 40 ft., and the highest banks 45 to 50 ft. This heavy work is usually very short.

Besides earth, there is cascalho, a sort of cemented gravel of volcanic origin and granite rock. The general average of excavation is about 10,000 cu.m. per kilometer, of which 90% is earth, 8% cascalho, and 2% rock.

The general alignment is sinuous. No money was spent to save curvature and to obtain the shortest and straightest line. On the contrary, great effort was made to obtain the line which could be quickest built and at the smallest expense. That even this line has involved enormous expenditures may be gathered from the fact that the cost of the engineering department to date has been one million dollars.

Everything here except right-of-way is expensive. All classes of labor are paid

from three to five times what would be a fair price in the States; the work done per man is perhaps from one-half to one-third what it would be in the States. The laborers are of many nationalities; their language truly polyglot. But the cost of all is tremendously enhanced by the high cost of living and transportation. Engineers' messes, when a number of white men live in fixed camps, cost from $3 to $5 per day per man. The cost of transportation, and the relative value of the different methods of transportation, is well shown by the cost of cement per barrel delivered upon the ground for a culvert on kilometer 244:

1 bbl. Europe to Porto Velho, 5000 miles, cost of cement and freight	$3.00
1 bbl. Porto Velho, by railway to Camp 26, 160 km	2.00
1 bbl. Camp 26 to 36, Batelao, 85 km	26.00
1 bbl. Camp 36 to work, pack mules, 5 km	9.00
Total	$40.00

The last item seems excessive, but it includes the cost of the trail, and part of the cost of bringing the mules to that part of the work.

Marvelous has been the skill and foresight of the contractors in providing an ample commissary and an unbroken line of supplies in this desert country, for a railroad in construction, like an army in the field, moves only on its belly.

Mountain ranges are not impassable, and deserts not so impenetrable as is this wildwood jungle which savage nature has set as the most perfect barrier to intercommunication. By the aid of river transportation, costly and dangerous as it is, the contractors have been able to maintain a working front of from 50 to 70 km. Without the rivers, the working front would have been limited to pack-mule service, and been restricted to 10 or 15 km. and the work which will now be finished in six years from the date of beginning, would have dragged on many years.

The rails used came from France. They weigh 25 kilos per lineal meter, and are laid upon cross ties brought from Australia. These are so hard that all the spike holes have to be bored by machinery. Eleven Baldwin locomotives are in service. The tariff from Abuna to Porto Velho, 136 miles, for a first-class passenger is 70$200 or $22.65. The freight on a ton of rubber for the same distance is about $136.

[A long, illustrated article on the construction of this railway, written by John Y. Bayliss, principal assistant engineer of construction, appeared in our issue of Oct. 28, 1909. Earlier references, consisting of a review of an important book on the engineering and construction expedition of 1878, and of a number of letters relating directly to the railway or brought out, in turn, by these letters, have appeared in our columns, as follows.—ED.]

Oct. 17, 1907; p. 449; Review of "Recollections of an Ill-Fated Expedition to the Headwaters of the Madeira & Mamoré Rivers in Brazil. By Neville B. Craig and others. Philadelphia: J. B. Lippincott & Co.

Oct. 17, 1907: Letter on "The Survey of the Madeira & Mamoré R.R. in Brazil." By Ernest H. Liebel.

Oct. 24, 1907: Letters from F. Lavis, Charles J. Seibert and E. L. Corthell, prompted by the Liebel letter.

Oct. 31, 1907: Letter from Torsten Carlander, differing with Liebel.

March 26, 1908: Letter from John K. Flick, and extracts from a letter from another engineer; both these men were connected with the railway.

Nov. 12, 1908: Short article (with portrait) noting a dinner to Col. Geo. E. Church, an engineer who was engaged in promoting the railway from 1868 to 1879; also view of the first locomotive run on the railway, the date having been July 4, 1878.

An Investigation of Relative Economy in Simple Timber Roof Trusses

BY WM. CLYDE WILLARD*

The main exhibit buildings used at "expositions" or "exhibitions" of a large scope are halls of temporary nature. In a general sense the structure of each may be divided into floor and substructure, roof and its supporting columns, and exterior walls of the building. Exclusive of all exterior decorative finish, etc., or unusual pile foundations, the roof system (which we will consider to include the roof covering, roof trusses, and supporting columns above the floor level) will probably represent the major portion of the cost of the structure. Therefore, in an exposition where from 70 to 100 acres will be under roof, the cost of this roof alone may be from one-half to two million dollars or more, the actual cost depending on a variety of conditions over some of which the engineer has control to greater or less extent.

In the majority of past expositions, skeleton timber construction with timber roof trusses has been used. The World's Columbian Exposition at Chicago was one notable exception, steel being used there in the larger buildings.

The type of truss to be used is largely fixed by the general plan adopted by the architects. At the Louisiana Purchase Exposition Howe trusses (sometimes with and sometimes without light monitors) were used, with a built-up trestle supporting a barrel roof which formed the backbone of the building. At the Alaska-Yukon-Pacific Exposition, Howe trusses combined with Fink trusses with curved lower chord were used.

In the case of the main buildings of the Panama-Pacific International Exposition, several of the earlier architectural studies of the buildings showed a roof of sawtooth skylight construction, combined with a barrel roof over the two perpendicular main avenues of circulation. The object of this investigation was, therefore, to determine the spacing of trusses, length of span and type of truss which (under certain assumed gen-

*Assistant Engineer, Panama-Pacific International Exposition Co., Pine and Battery Sts., San Francisco, Calif.

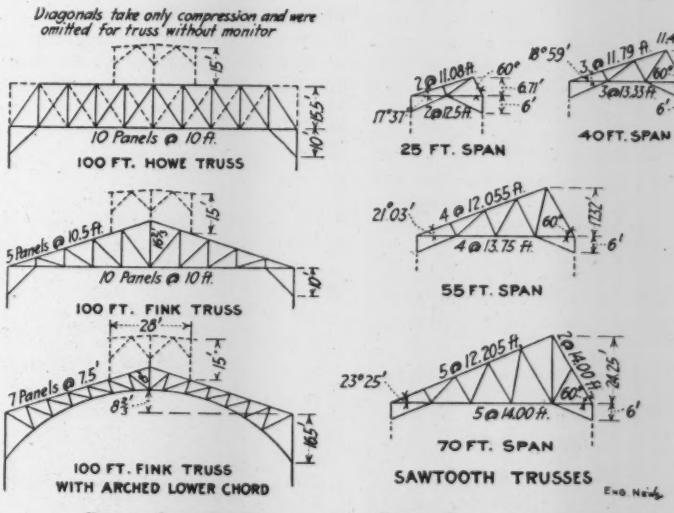

Diagonals take only compression and were omitted for truss without monitor
10 Panels @ 10 ft.
100 FT. HOWE TRUSS
5 Panels @ 10.5 ft.
10 Panels @ 10 ft.
100 FT. FINK TRUSS
7 Panels @ 7.5'
100 FT. FINK TRUSS WITH ARCHED LOWER CHORD
25 FT. SPAN
40 FT. SPAN
55 FT. SPAN
70 FT. SPAN
SAWTOOTH TRUSSES

FIG. 1. OUTLINE SKETCHES OF TRUSS TYPES INVESTIGATED

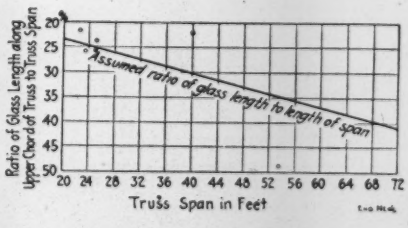

Assumed ratio of glass length to length of span
Ratio of Glass Length along Upper Chord of Truss to Truss Span
Truss Span in Feet

FIG. 2. RATIO OF SKYLIGHT LENGTH TO TRUSS SPAN FOR SAWTOOTH TRUSSES

(The plotted points show the conditions in six existing sawtooth trusses in various localities. The length of 60° side of the top chord for the present investigation was obtained by adding 1½ ft. to the ordinate of the above curve, as the sum of the margins required at upper and lower edges of the skylight).

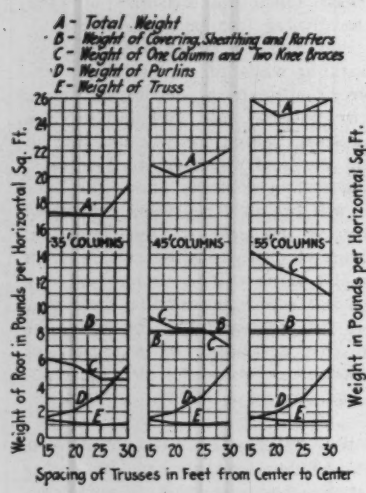

A - Total Weight
B - Weight of Covering, Sheathing and Rafters
C - Weight of One Column and Two Knee Braces
D - Weight of Purlins
E - Weight of Truss
35' COLUMNS
45' COLUMNS
55' COLUMNS
Weight of Roof in Pounds per Horizontal Sq. Ft.
Spacing of Trusses in Feet from Center to Center

FIG. 3. CURVES TO SHOW ECONOMICAL SPACING OF SAWTOOTH TRUSSES

(Calculations for 40-ft. span).

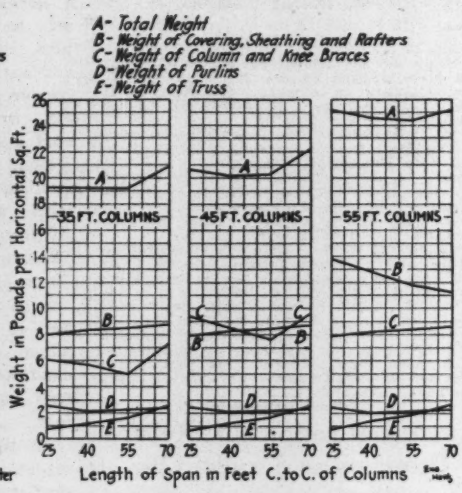

A- Total Weight
B- Weight of Covering, Sheathing and Rafters
C- Weight of Column and Knee Braces
D- Weight of Purlins
E- Weight of Truss
35 FT. COLUMNS
45 FT. COLUMNS
55 FT. COLUMNS
Weight in Pounds per Horizontal Sq. Ft.
Length of Span in Feet C. to C. of Columns

FIG. 4. VARIATION OF ROOF WEIGHT WITH LENGTH OF SPAN, FOR SAWTOOTH TRUSSES SPACED 20 FT.

(Weights given are per square foot of ground area).

eral conditions) would give the minimum total cost of construction. The results are shown herewith by diagrams. These results should be considered as relative only, since at the time of the investigation practically no definite plan for the exposition had been adopted, the sizes and shapes of buildings, widths of aisles, desired clear areas of exhibit spaces, headroom, etc., were all unknown, and a change or an error in the corresponding assumptions made in the investigation will alter the absolute values but will affect the relative values only slightly.

General Assumptions—The investigation was based upon the following general assumptions, which were uniformly followed:

1. A maximum of headroom would be required, limiting the depth of kneebraces to 6 ft. for all spans of less than 100 ft., and to 10 ft. for spans of 100 ft. or greater. (The cost of columns may be reduced, of course, by increasing the depth of the kneebraces.)
2. The columns were designed for a solid section. (Here again the cost would be reduced by using a built-up, partly hollow or open, section).
3. The horizontal wind-pressure was taken as 30 lb. per sq.ft. For inclinations less than 45° the wind pressure was taken as two-thirds the angle of inclination. For inclinations of 45° and over the full horizontal pressure was used. These values represent the maximum intensity of wind pressure recorded for the localtiy.
4. On account of local climatic conditions no snow load was considered.
5. All truss members were computed to be of timber.
6. Each truss was considered to have a truss ahead and one back of it, so that but one column was considered for each. The column was considered hinged at the base, to have no lateral load upon itself, and was designed to resist the maximum bending moment due to the full wind on each truss.
7. Two computations having shown that the weight of truss connections was about 10% of the total center-length weights of the members, the total weight of truss was in all cases determined from the actual center length weights, by adding 10% for connections. Professor Ricker, in Bulletin 16 of the University of Illinois, states that from an investigation conducted by himself he found the weight of connections to be about 6% of the center length weights. His truss weights are, however, much in excess of the weights found herein, due doubtless to difference in assumed loading. It would appear that as the weight of truss for a given span decreases for diminishing loads, the weight of connections decreases by a less proportion of the total.

Unit-stresses and Weights—All timber was considered to be of Douglas Fir. The following units were assumed:

	lb. per sq.in.
Modulus of Elasticity	1,500,000
Compression	1,400
Shear across grain	1,400
Bending, extreme-fiber stress	1,400
Tension with grain	1,200
Shear with grain	300
Bearing across grain	300

	lb. per sq.ft. surface
Weight of skylight glass and frame	6
Weight of roof covering (Felt paper)	2
Weight of sheathing	4
Weight of timber, per ft. B. M., 4 lb.	

The various types of truss investigated are shown in outline by Fig. 1.

SAWTOOTH TRUSS

Due to the fact above stated, that several architectural studies showed sawtooth roof construction, and also because that particular form of truss is not in extensive use, the sawtooth truss was investigated more in detail than the other forms of trusses. It was assumed that the necessary area of skylight would increase as the length of span increased, thereby increasing the rise of the truss. The skylight side of the truss was in all cases fixed at 60° with the horizontal. From an investigation of all available data on existing similar types of construction, supplemented by a rough calculation of required glass area for proper diffusion of light, the curve shown in Fig. 2 was plotted. This was then used as a basis for determining the height of truss.

Truss Spacing—An investigation as to the economic spacing of trusses was made. The results, plotted in Fig. 3, showed this to be about 20 ft. The economic spacing of trusses does not appear to be greatly affected by the kind of truss or the variation (within reasonable limits) of the magnitude of loads, so that this value may be compared with results obtained by other investigators. Such a comparison shows a close agreement between this and values obtained elsewhere.

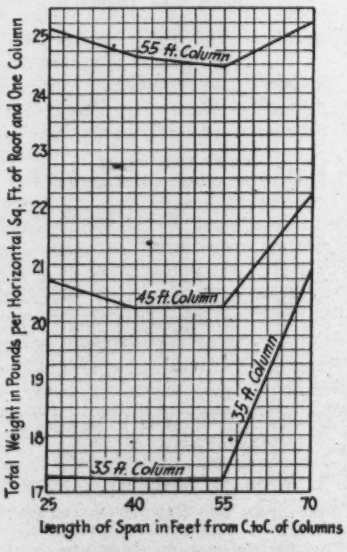

55 ft. Column
45 ft. Column
35 ft. Column
Total Weight in Pounds per Horizontal Sq. Ft. of Roof and One Column
Length of Span in Feet from C. to C. of Columns

FIG. 5. CURVES OF TOTAL ROOF WEIGHT FOR VARYING SPAN, FOR THREE HEIGHTS OF COLUMN

(From Fig. 4).

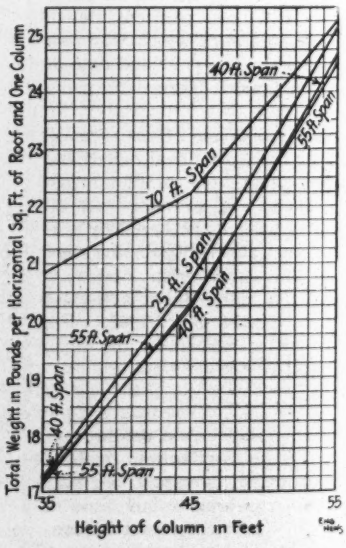

40 ft. Span
35 ft. Span
25 ft. Span
55 ft. Span
Total Weight in Pounds per Horizontal Sq. Ft. of Roof and One Column
Height of Column in Feet

FIG. 6. TOTAL WEIGHT OF SAWTOOTH ROOF FOR VARYING HEIGHT OF COLUMN, FOR FOUR DIFFERENT SPANS

(Curves of Figs. 4 and 5 rearranged)

Span Length—As mentioned above, the inside height of buildings was not definitely settled upon, and, therefore, a comparison of weights for different spans was made for columns 35, 45 and 55 ft. high. Fig. 4 shows the final itemized results, and the totals are grouped in Fig. 5. The curves of total weights from Fig. 5 are arranged on the bases of column heights in Fig. 6. The latter diagram indicates clearly that for a sawtooth truss, for any height of column between 35 and 55 ft., the span of minimum roof weight is from 40 to 55 ft.

Comparison of Different Truss Types

In comparing different truss types, it was necessary to consider not only the weight of roof, but also its cost, as the costs of the several items of roof weight differed. Therefore the weights were classified as follows:

1. Purlins, including also a light system of bracing between trusses.
2. One column and two kneebraces.
3. Roof covering, sheathing and rafters.
4. Truss.

Column footings were omitted from the investigation. Some buildings will require pile foundations, while others will not. The foundation conditions being so variable, to try to include them was thought to be worse than useless.

The following seven forms of truss were investigated:

1. Sawtooth truss.
2. Fink truss with direct skylight in roof.
3. Fink truss with monitor at peak.
4. Fink truss with arched lower chord and direct skylight.

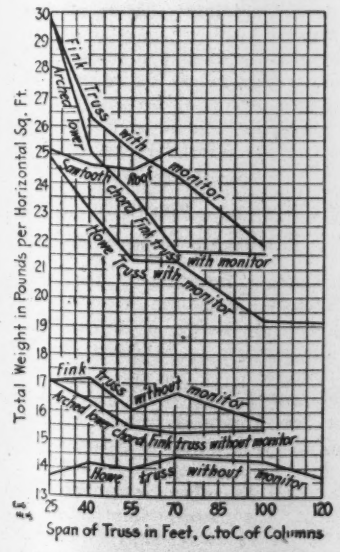

Fink Truss with Arched Lower Chord and Sawtooth Roof
Fink Truss with monitor
Howe Truss with monitor
Fink Truss without monitor
Arched Lower Chord Fink Truss without monitor
Howe Truss without monitor
Total Weight in Pounds per Horizontal Sq. Ft.
Span of Truss in Feet, C. to C. of Columns

Fig. 8. Variation of Total Roof Weight with Span, for Seven Truss Types

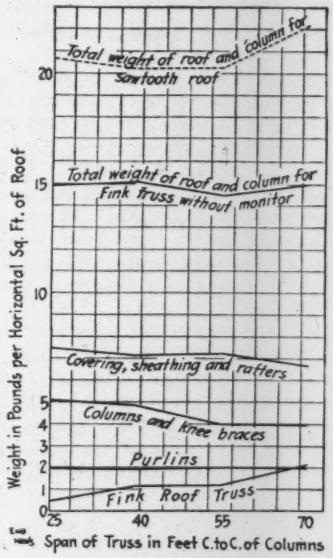

Total weight of roof and column for Sawtooth roof
Total weight of roof and column for Fink truss without monitor
Covering, sheathing and rafters
Columns and knee braces
Purlins
Fink Roof Truss
Weight in Pounds per Horizontal Sq. Ft. of Roof
Span of Truss in Feet C. to C. of Columns

Fig. 7. Variation of Detail Weights with Span for Fink Truss (55-ft. columns, 20-ft. spacing).

5. Fink truss with arched lower chord and monitor at peak.
6. Howe truss with standard flat-roof skylight.
7. Howe truss with central monitor.

The computations were all made for columns 55 ft. high and for 20-ft. spacing of trusses. As an example of the itemized weight computations Fig. 7 is given, showing the results for a Fink truss. The rise of the Fink truss was in every case one-sixth of the span.

The final results are brought together in Figs. 8 and 9, giving, respectively, total weights and total costs of the different types for varying span. In transforming from Fig. 8 to Fig. 9 the following costs were used:

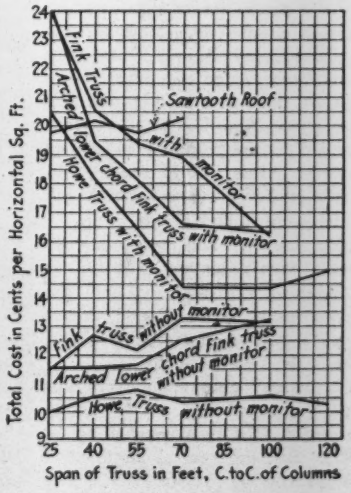

Fink Truss Arched Lower chord and Sawtooth Roof with monitor
Howe Truss with monitor
Fink Truss without monitor
Arched Lower chord Fink truss without monitor
Howe Truss without monitor
Total Cost in Cents per Horizontal Sq. Ft.
Span of Truss in Feet, C. to C. of Columns

Fig. 9. Variation of Roof Cost with Span for Seven Truss Types

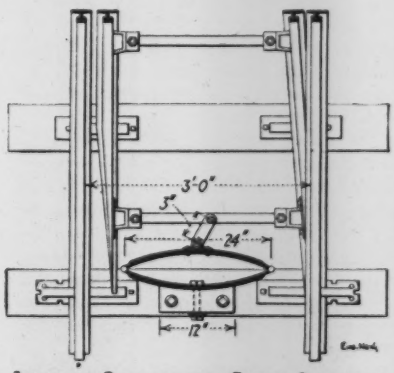
Item.	Cost of Material per 1000 ft. B.M. or per 4000 lbs.	Cost of Labor per 1000 ft. B.M. or per 4000 lbs.
Roof covering, sheathing and rafters	$16.00	$ 8.00
Purlins	19.00	10.00
Howe and Fink truss frame	16.00	15.00
Sawtooth truss frame	16.00	16.00
Arch Fink truss frame	16.00	17.00
Columns	27.00	12.00

The additional cost of skylight surface beyond that of the regular roof covering was ignored, on the assumption that for any form of truss used the skylight area and cost would be approximately a constant for a given span, and for the reason that relative rather than absolute values were desired.

Timber and Steel Columns—It was apparent that the cost of columns would be a large item of the total, and a comparison was made between timber and steel for columns. This showed that, with steel at $70, the value used in all preliminary cost estimates for the exposition, timber would have to cost upward of $100 per M ft. B. M. before steel would be as cheap to use.

A Locking Switch for Mine Inclines

In the operation of cable inclines at mines trouble occurs frequently through cars taking the wrong track owing to a misplaced switch at the connection of the three-rail and two-rail portions of the incline. A spring locking switch to eliminate accidents of this kind is described in *Coal Age* by A. W. Evans.



Locking Switch for Cable Inclines at Mines

He states that for 18 years he has been in charge of mining operations where gravity planes were used, and in the history of each plane (where the arrangement of three rails above the parting and two below was used) a number of wrecks occurred at the switch.

The locking device is simple in construction and positive in action. It consists essentially of an elliptical spring (usually an old buggy spring) bolted to a block of wood and secured to a track tie, as shown, with one side of the

spring fastened to the switch rod by the swing link shown. Its action is to hold the switch point close to the stock rail, whichever track the switch may be set for. Each descending car sets the switch automatically for its own track, and the spring practically locks the points in position, insuring a safe delivery of this car over the proper track to the head of the incline.

A Simple Method of Plotting Soundings in Hydrographic Surveys

By R. R. Raymond*

The geometrical solution of the three-point problem given in this article, while it is not new, is so convenient and useful for plotting the positions of soundings that the author believes it worth while to bring it to the attention of hydrographic surveyors. It was used by the author in 1895, and was later independently proposed by Prof. A. Llano in an article in Engineering News of Dec. 29, 1904. Certain simplifications in its use and its particular adaptability to hydrographic surveying have not, however, been pointed out before.

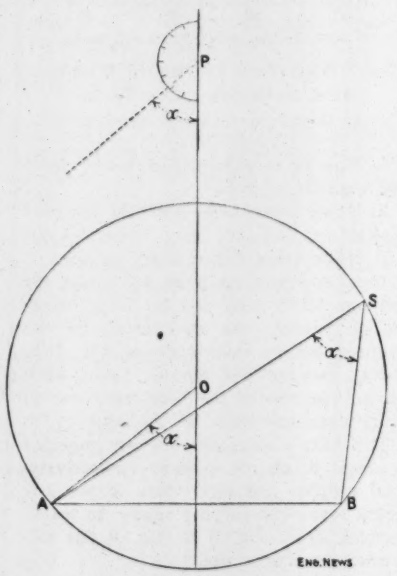
A sextant angle between two fixed points on shore is measured at a boat in order to locate a sounding. The problem is to determine the locus of all points at which the observed angle could be found. A complete solution of the location of the sounding demands that two loci be determined, whose intersection is the desired point. Several cases arise in ordinary practice. We will not discuss all methods of locating soundings, but will consider only those cases in which at least one angle is measured at the sounding boat.

One locus may be established by a fixed range on shore. The plotted soundings all fall on the plotted line of this range. The method of procedure is to plot the range on the map and then determine another locus for each sounding by the method about to be described; the intersection of the new locus and the plotted range completely locates the sounding.

Instead of a fixed range, a transit may be set up on shore and the azimuth of each sounding may be measured. The plotting in this case requires the laying down on the map of a new azimuth for each sounding, which would soon confuse and mar the map if many points were to be plotted. To avoid this, it is customary practice to construct a protractor on the map itself with its center at the plotted position of the transit station; and by stretching a thread from a needle set in this center to establish the azimuth without drawing a pencil line. The intersection of the thread with the other locus of the sounding will locate the desired point.

If no angle or range on shore is used, then two angles must be measured by the sextant in the boat. This is usually done by selecting three points on shore, designated, let us say, A, B and C. The angle between A and B is measured and also that between B and C. This presents the well known three-point problem. In practice it is usually solved mechanically by means of a three-arm protractor.

The ordinary geometrical solutions are too cumbersome for use when many points are to be plotted. The method previously referred to is more accurate than the mechanical method, and it is so simple as to be fully as rapid. Unlike the mechanical method, which is



limited by the protractor to three points, this method is equally applicable if four points are used, say A and B for one angle and C and D for the other. The application of this method is illustrated by accompanying figure.

Let A and B be the plotted positions of any two fixed points. It is required to construct the locus of a point S at which the angle between A and B is α.

Draw the line AB and at its middle point erect a perpendicular. Through A draw AO making the angle α with the said perpendicular. With O as a center and OA as a radius, describe a circle. This circle is the desired locus.

For let S be any point on the circumference on the same side of AB as O. Then the angle ASB is measured by ½ the arc AB. But the central angle at O is also measured by ½ arc AB. The angles are therefore equal and consequently angle ASB is equal to α. That is, all points on the circumference on the same side of AB as O fulfill the condition of having the angle between A and B equal to α.

No point, as S', not on the circumference, can fulfill this condition; for we may pass a circle through A, B and S' and then the angle $AS'B$ will be measured by ½ the new arc AB; but if two arcs having the same chord have the same angular value they must have the same radius. That is, the new circle through S' is the same circle already constructed, if the angle $AS'B$ is equal to α.

In applying this method to a large number of soundings, the procedure is as follows: Draw the chord AB and at its middle point erect the perpendicular. At a convenient point on this perpendicular, as P, construct a protractor with center at P and zero of the scale on the perpendicular. (Instead of constructing the protractor on the map, a paper protractor may be fastened in position by thumb tacks.)

To find the locus of any sounding, lay the edge of a triangle on the protractor at the proper angle, then slide the triangle along a straight edge until the same edge passes through A, and mark O the intersection of the edge with the perpendicular; then draw the circle with radius AO, or rather draw the necessary arc of this circle. The intersection of this arc with the plotted range, with the thread stretched at the proper azimuth as measured by the transit, or with another arc constructed in the same way as we have just described, will locate the sounding.

In solving the three-point problem, after the proper perpendiculars and protractors have been laid down on the map, no construction lines are used other than the short arcs needed to get the intersection. These arcs can be laid out faster than a three-arm protractor can be set to the desired readings, and the plotting is more exact.

The above method was devised by the writer to meet a case where the sextant observer measured all his angles between two prominent objects on shore without regard to the transit station.

*Major, Corps of Engineers, U. S. A., Wilmington, Del.

Civil Service Examination for Building Inspector

A building inspector of the city of Philadelphia sends the following questions recently asked in an examination for appointment as "Building Inspector, Civil Engineer" in that city. The examination embodied these 12 questions and eight "experience questions" not given here, and covered an allotted period of 5½ hr. No assistance from handbooks, slide-rules or other instruments was allowed. The correspondent calls attention to the impracticability of questions 10, 11 and 12 in view of the fact that no handbooks were allowed. The questions follow:

PRACTICAL QUESTIONS

1. Define modulus of elasticity; modulus of rupture; dead load; live load; factor of safety; tension; shear; compression; torsion; transverse stress.

2. Give the average bearing power of the soils in the vicinity of Philadelphia.

3. Given the dimensions of a three-story mill building to be 40x150 ft. with a live load of 120 lb. per sq. ft.; design the building.

4. Find the diameter and thickness of a cast iron column 12 ft. long, to carry a load of 175 tons.

5. Design a plate girder for 35 ft. clear span to carry a uniform load of 125,000 lb.

6. What are the duties of a Building Inspector?

7. What is a Fire Tower? Make sketches of two of the most common types.

8. Write the specifications for brick and stone foundations on concrete footings.

9. What is reinforced concrete? Sketch a section of column and beam and write the specifications.

10. What dimension of Georgia long leaf yellow pine should be used for a beam of 20 ft. span to carry a uniform load of 36,400 lb.?

11. Give the sizes and weights of I-beams to carry loads as follows;—

20 ft. span	80,000 lb.
25 ft. span	125,000 lb.
16 ft. span	65,000 lb.
18 ft. span	225,000 lb.
12 ft. span	45,000 lb.
17 ft. span	300,000 lb.

12. Work out the stresses and design the members of a roof truss as per sketch: Span 80 ft. in clear, resting each end on 26 in. walls; rise 14 ft.; roof 6 in. of concrete, 6 in. I-beam purlins at every panel point; no ceiling on lower chord; trusses to be spaced 20 ft. c. to c.

Level Crosswalks for Streets

A number of cities and towns in the middle West are adopting the practice of making the crosswalks at street intersections level with the tops of the curb. This is more convenient for pedestrians than where they have to step down to the gutter, and it is very little objectionable for vehicles, since the change from the normal crowning of the street extends only a short distance from the gutter. The accompanying cuts show the construction as used at Wheaton, Ill. It will be seen that a second curb is added for the width of the crosswalk (which has 15 lines of paving brick), and is sloped down at each end to the level of the gutter. A combination curb and gutter is used, and the second curb is included in the combination, making a homogeneous construction.

In the earlier arrangement the gutter was covered with a 2x10-in. plank carried by a couple of iron stirrups resting in recesses on the tops of the curbs. These reduced the waterway to such an extent, however, that dirt and drift lodged during rainstorms, backing up water and sediment along the gutter, while in heavy rains the planks were frequently washed out of place. In the newer work a cast-iron checker-plate cover is used.

In a patented arrangement on the same general plan, which has been used in Chicago, a concrete slab forms the cover. This is said to be ordinarily 4½ in. thick, which leaves a very shallow waterway unless a deep curb is used; but where the gutter is over 12 in. wide a thinner slab of reinforced concrete may be used.

Notes

An Example of Wild Bidding in German contracting is reported in the journal "Armierter Beton," of August, 1912. A railway contract involving something over 100,000 cu.yd. of earthwork was opened for bidding. Twenty-six bids were received. The lowest bid was 46,340 M., and the highest bid was 192,775 M. The other 24 bids ranged between 48,000 and 103,000 M.

Spring Dancing Floors—A recent query on this subject is answered by L. A. Bostwick, Dallas, Tex., as follows:

In reply to your query as to spring dancing floors, I will say they have been in use for 50 years or more in the old hotels of western New York. My people advise me that they were in common use at that time and were considered very fine by the dancers. I do not know of their use in modern ball-room floors, as it spoils them for other purposes. A few years ago I saw in the old Stone Hotel at Caledonia, N. Y., one of these floors, and I think it is still in use. I think some of the old carpenters could advise as to its construction.

Gummed Letters for Tracings—Prof. H. N. Holmes, Richmond, Ind., recommends the use of gummed letters and figures for lettering tracings quickly and neatly. He remarks that such letters and figures are on the market and can be had in various sizes and styles at a low price. They can be pasted on the tracing sheet and will make a perfect blueprint.

40-Carbon Shape-Steel. A catalogue (illustrated list) of angles, tees and miscellaneous rolled shapes made from used Bessemer rails was recently issued by the Buffalo Steel Co. (Tonawanda, N. Y.) These shapes are available for framing of miscellaneous articles, machinery, etc., where the fact that their elastic limit is considerably higher than that of standard structural steel is an advantage, and where bending and similar working are done hot. They are not advertised for structural use. As an example of the sizes, we note that the angles shown range from ¾x¾x⅛ to 2½x2½x⅜-in.

The book is useful as a reference list of a line of material that will often prove serviceable in various odd jobs in contracting or manufacturing.

Difficult Caisson Work for a building foundation is in prospect in constructing the new Western Union Building in New York City. At the site of the building, bedrock is 72 ft. below curb level, and the overlying material is sand, with groundwater-level about 30 ft. below curb level. The general excavation will be carried down 62 ft. below the street, at which depth the basement floor will be laid, about 30 ft. below groundwater-level. The site is surrounded by heavy stone buildings of heights up to 11 stories, and most of these are on spread footings, some as shallow as 20 ft. below curb level. The excavation for the basement under these circumstances is bound to prove a delicate and difficult undertaking. The contract was recently awarded to The Foundation Co., New York City.

Churn Drilling Methods and Costs—In the southwestern part of the United States, in New Mexico and Arizona, churn drilling outfits are extensively used for exploring for deposits of ore, which are primary enrichments of copper overlaid by a zone of leached iron-stained rock of the porphyry or granite type. Such deposits as those in the Chino, Ray and Miami districts are fairly uniform in extent and cover areas varying from one to five square miles. In a recent issue of the "Harvard Engineering Journal," Fred B. Ely gives the following points in regard to the methods used in these districts:

Before starting the actual drilling operations, considerable preliminary surveying and mapping are required. It is the practice to lay out the ground in coördinates usually on true north and

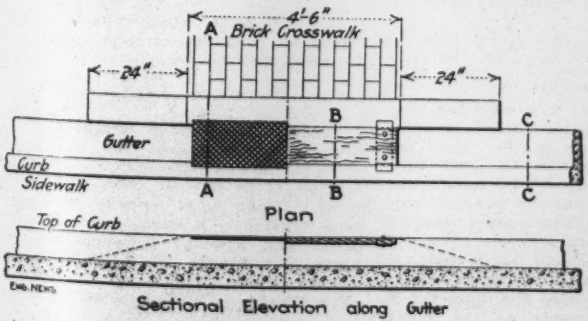


FIG. 1. PLAN AND ELEVATION OF DOUBLE CURB GUTTER WITH LEVEL CROSSWALK AT STREET CROSSINGS; WHEATON, ILL.

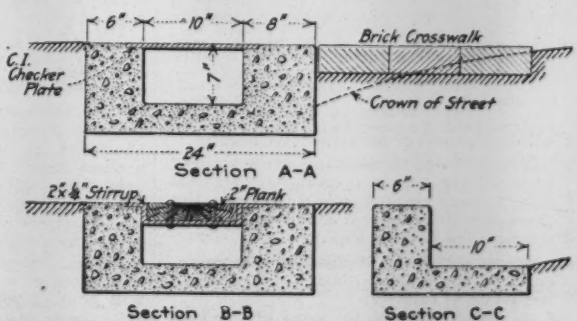


FIG. 2. SECTIONS OF DOUBLE-CURB GUTTER FOR LEVEL CROSSWALK

COST OF CHURN DRILLING PER FOOT

1910	Labor	Firemen	Coal	Supplies	Sampl'g	Assaying	Teaming	Equip't	Admin.	Water	Total
Dec.....	$0.83	$0.031	$0.162	$0.23	$0.216	$0.12	$0.09	$0.19	$0.14	$0.06	$2.07
Jan.....	1.00	0.03	0.55	0.12	0.24	0.10	0.13	0.24	0.16	0.07	2.64
Apr.....	0.895	0.03	0.135	0.20	0.176	0.099	0.127	0.243	0.10	0.076	2.10
May.....	0.776	0.03	0.262	0.06	0.146	0.061	0.107	0.24	0.10	0.068	1.85

south lines and place the drill holes on the coördinate corners.

In the first drilling it is customary to locate the holes rather promiscuously in order to ascertain the general extent or boundaries of the ore. Then as the drilling progresses, the holes are spaced 200 ft. apart and sometimes 100 ft., until the entire deposit is covered. This will give data which will permit calculating the exact ore tonnage, assuming, of course, that the ore lies regular and unbroken between the holes.

As the primary object of drilling is to ascertain the nature of the ground passed through and the mineral contents, too much care cannot be taken in sampling. Every 3 or 5 ft. the tools are removed and the hole bailed out. The sludge is emptied into a trough, at the end of which is attached a split divider, a modification of the Jones sampler, and the sample is reduced to ¼ or ⅛ its original size. This is usually cut down again until we have about ½ of the original or a 14-quart pail full. The sample is then dried on a sheet-iron stove placed conveniently near the drill, and then sent to the assay office. Here it is ground down to pass through a 10-mesh screen and further reduced by a Jones sampler. (This coarse grinding operation is necessary since the sludge cakes up in drying.) The final amount, enough to fill an assay envelope, is bucked down to pass through an 80-mesh screen. This is assayed for copper and other minerals if necessary.

Churn drilling as applied to development of the low-grade porphyry orebodies is comparatively new, and, therefore, it is not surprising that there has been considerable scepticism as to the reliability of the results. The experience of the past few years, however, has proved that the assays of the drill samples are inclined to run lower than the actual groove samples taken from the rock. This was found to be the case at Ray, Miami and Chino districts where raises have been put up alongside of drill holes. Thus the drill samples can at least be said to be on the safe side.

The types of drills used in the Southwest for the development of disseminated copper deposits are the Cyclone, Star and Keystone. It is customary to work two shifts of 12 hours each, changing at 12 noon and 12 midnight. The driller is paid $6 per shift and the helper $4.50 per shift. The cost data given are fair averages for drilling under conditions met with in the Southwest. In places where the country is very rough the cost of road making in order to move a drill to the required location will average from 10c. to 20c. per ft. These roads are sometimes blasted out of solid rock. The grade, if possible, is kept down to a maximum of 18%.

Nervous Iron—A description of a primitive form of quality test for iron, recorded by Grignon, writing in 1775, is quoted in a recent English pamphlet by Charles Fremont, of Paris, entitled "Why the Titanic Sunk," as follows:

The first trial to which iron will be submitted to be assured of its quality will be to cut the bars at each end to recognize the grain. To this end, one will begin to cut the surfaces with a chisel, on corresponding lines; then one will finish to separate the pieces by breaking them with a sledge-hammer; then one will examine the iron at the break. One will compose the lot of the first quality of bars with brawny break, that is to say nervous iron which tears; the nerve will be long, well brawny, of an ashy grain, silvery, well twisting. The bars with rough-grained break, in iron that breaks, will be put in the lot of second quality.

It is pathetic to read the word "tears" immediately after reading "nervous iron"; tears might mean weeps. But there is some reassurance in learning that the nerve is well brawny.

Street and Road Widths—A correspondent in a New England college town writes us as follows:

I am rerunning the lot lines of the property of an educational institution, which owns a large part of the town in which it is located. The older streets were laid out about 1795 and in some cases can not be relocated exactly. But the widths are given, and in some cases enough other data so that the original layout can be retraced. The question which I wish to raise is, If there are well established bounds on both sides of the road or street, which are, however, nearer together than the specified width of the street, do these bounds hold, or are the bounds to be reset to conform with the width called for? It seems to me and to those with whom I have talked, some engineers and road commissioners, that the street width should hold. I should like to hear of any legal settlement of such a question, and the opinions of other engineers.

The question which our correspondent raises is one not well covered in books on surveying and law, as nearly as we can determine. Where a strip of land has been deeded by private owners to the public for use as a street, we believe it to be a well established and clearly defined principle that the public (the city, town, county, or state) is entitled to the full width specified, notwithstanding monuments, howsoever established, to the contrary. Adverse possession does not hold against public property and encroachments must be removed when so ordered. Exceptions to this rule are so rare that they would seldom be of interest to engineers unless all the intricate details of the case were also given. In the above instance it would be essential to know what the bounds mentioned are, whether they are land bounds established by surveyors for the abutting property owners, or highway bounds established by a surveyor with public authority.

Platting Topography in the Field—In place of the usual method of taking transit or stadia topography by notes and mapping in the office, L. A. Sumner, Asst. Engineer, G. T. P. Ry., Elbow, Sask., recommends a method of direct platting in the field:

The taking and platting of contour topography on railroad preliminary lines by the usual method of taking it in the field in large expensive cross-section books can be improved on by the following method: It was new to me until recently. We take our topography in the field on long strips of profile paper, folded and tacked to a small board to the same scale used in the office map for projection. The draftsman takes the sheets and lays them in the proper place over the preliminary line and with a piece of carbon paper traces the topography on the map exactly as it was taken in the field.

As a rule, the ordinary profile paper is not to true scale and must be corrected up every 1500 or 2000 ft. to fit the map exactly.

The ordinary carbon paper is too smudgy and makes too coarse a line. A better plan is to use a sheet of transparent profile or cross-section paper with some soft graphite rubbed over one side.

The Strength of Transmission-Line poles is often calculated on the assumption that the weakest section is at the ground line. Edward Taylor, 132 Lincoln Place, Brooklyn, N. Y., points out that in a conical beam the weakest section is at an intermediate point, and he gives the result in very handy form. If a transmission-line pole be considered as a piece of a cone, the weakest section will be at a point where the diameter is 1½ times the diameter at the point where the horizontal bending force is applied (i.e., at the center of the group of cross-arms). The verification of this formula is readily carried out by expressing the diameter of any section and the moment of resistance at this section in terms of the diameter at the point where the horizontal bending force is applied. Computing the moment for any section in similar terms, and forming an expression for the extreme fiber stress at any section, differentiation of this expression will give the condition for maximum. As above stated, the maximum occurs at the point where the diameter is 50% greater than at the point of application of the force. When more than one bending force is applied the point where the initial diameter is to be measured is at the resultant of the forces.

This calculation takes no account of the vertical load, but as in line poles the vertical compression is usually slight, it is justifiable to consider as the weakest section that one which is subjected to the greatest intensity of stress under a given bending force.

A Chimney Formula—In investigating existing chimney stacks it is sometimes necessary to know the stability under wind velocities or limiting stresses other than those used in the design. F. W. Hoyt, of M. W. Kellogg Co., New York, gives the formula applicable in such cases. Primarily it fits the following condition:

An existing stack is known to have been so designed that a wind pressure of p lb. per sq.ft. will give a windward-side tension of b lb. per sq.in. It is desired to know at what wind pressure the compression on the windward side is just neutralized (i.e., zero tension), this being usually considered as the limiting condition for masonry; or, more generally, at what wind pressure the windward-side tension will be d, different from b.

Calling the weight of the stack W, its horizontal cross-sectional bearing area S, the total extreme fiber stress produced by the wind will be, in the two cases, $\frac{W}{S} + b$ and $\frac{W}{S} + d$. These are proportional to the bending moments, and therefore to the wind pressures, or

$$\frac{p_1}{p} = \frac{\frac{W}{S} + d}{\frac{W}{S} + b}$$

where the subscript 1 refers to the condition when the windward-side tension is d. The pressures being proportional to the squares of the wind velocities,

$$\frac{p_1}{p} = \frac{V_1^2}{V^2}$$

Therefore,

$$V_1 = V\sqrt{\frac{\frac{W}{S} + d}{\frac{W}{S} + b}}$$

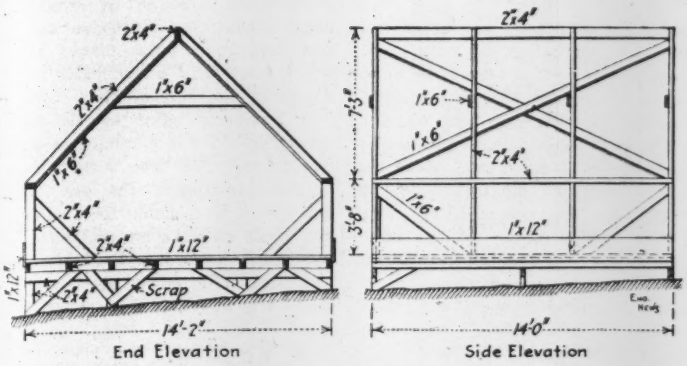
If $d = 0$, or the stack is to be investigated for condition of zero tension, this formula may be changed to

$$V_1 = V\sqrt{\frac{W}{W + 8b}}$$

EXAMPLE—A stack weighs 400 tons and its sectional area near the base is 40 sq.ft. It was designed for a maximum tension of 50 lb. per sq.in. at 100-mile wind. What wind velocity will give zero tension? Reducing the weights, areas and stresses to pound-and-inch units, $W = 800{,}000$ lb., $S = 5760$, $b = 50$.

$$V_1 = 100\sqrt{\frac{800{,}000}{800{,}000 + 288{,}000}} = 85.6 \text{ mi. per hr.}$$

This calculation does not involve any formula for variation of wind pressure



FRAME AND FLOOR FOR TENT

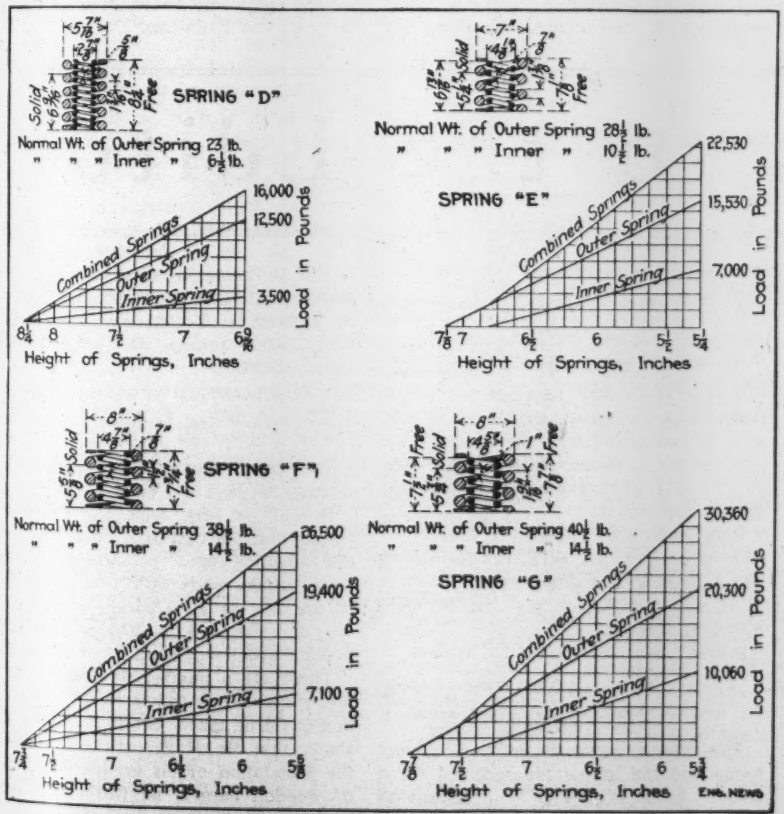
(For large tent; small tent frame similar but only three pairs rafters.)

with velocity. The M. W. Kellogg Co. engineers use $p = 0.005\ V^2$ as a base, and, applying this formula directly to the diametral projection, use the full value of p for square stacks, ¾ p for octagonal stacks, and ½ p for round stacks.

Load Diagrams for Spiral Springs

The accompanying diagrams, which have been sent to us by a correspondent, will be found useful in saving calculations when the amounts of compression of the standard M.C.B. springs *D*, *E*, *F* and *G* are required for given loads.

In the upper left-hand corner of each diagram is given a section of the spring with all dimensions. On the base of the diagrams are the heights of springs ranging from the maximum for the springs free to the minimum for the springs solid. The loads on the vertical leg of the triangle are the maximum loads with springs solid, which in the case of spring *D* is 16,000 lb., the load on the outer spring being 12,500 lb. and on the inner spring 3500 lb.



LOAD DIAGRAMS FOR STANDARD M. C. B. SPIRAL SPRINGS, D, E, F AND G

Cost of Framing and Flooring Tents

BY R. C. HARDMAN*

The writer had occasion recently to frame and floor a number of tents constituting a permanent camp, the costs of which might be of value to engineers contemplating such work.

The tents were of two sizes, viz: 14 ft. by 14 ft. 2 in., and 6 ft. 11 in. by 8 ft., respectively, and were framed as shown in the accompanying sketch. The smaller tent had but three pairs of rafters instead of four, as shown for the larger. All tents were on a side hill and were leveled. The amount of material used is given below for frame and floor complete, with its cost. The labor cost and total cost were as tabulated.

Large Tent,		
500 ft. B.M. lumber at $30.00		$15.00
7 lbs. nails at 0.05		.35
		$15.35
Small Tent,		
185 ft. B.M. lumber at $30.00		$ 5.55
5 lbs. nails at 0.05		.25
		$5.80

LABOR COST OF FLOORING AND FRAMING

		Cost	Cost per Tent
Tents 14 ft. by 14 ft. 2 in.			
38 Frames:			
Carpenters...	32 hrs. at $0.50	$16.00	
Carpenter helpers.....	129 " " 0.375	48.38	
Laborers....	19 " " 0.25	4.75	
Laborers....	11 " " 0.20	2.20	
		$71.33	$1.877
42 Floors, average height 1 ft. above ground, leveled			
Carpenters...	72 hrs. at $0.50	$36.00	
Carpenter helpers.....	153 " " 0.375	57.38	
Laborers.....	81 " " 0.25	20.25	
Laborers.....	19 " " 0.20	3.80	
		$117.43	2.796
			$4.673
Tents 6 ft. 11 in. by 8 ft. 4 in.			
16 Floors, average height 1 ft. above ground, leveled			
Carpenters...	9 hrs. at $0.50	$4.50	
Carpenter helpers.....	26 " " 0.375	9.75	
		$14.25	0.891
16 Frames:			
Carpenters...	5 hrs. at $0.50	$2.50	
Carpenters helpers.....	23 " " 0.375	8.75	
		$11.25	0.703
			$1.594

TOTAL COST OF FRAME AND FLOOR

	Large Tent	Small Tent
Material.....	$15.35	5.80
Labor.....	4.67	1.59
	$20.02	7.39

Keeping Records of Municipal Improvements at Fargo, N. D.†

BY FRANK L. ANDERS‡

The City Engineer's department has felt the need of complete and accurate maps of the city for all purposes, and I believe and in some instances know, that serious errors have been made by relying on maps that were unreliable.

*Civil Engineer and Superintendent of Construction, Fort Huachuca, Ariz.

†From the report of the City Engineer of Fargo, N. D., 1910-12.

‡City Engineer, Fargo, N. D.

Two sizes of maps have been adopted for our use. A large map on a scale of 200 ft. to the inch shows all sections, quarter-sections, additions, streets, avenues, alleys, and blocks and lots. On these maps will be plotted all municipal improvements, such as sewers, water mains, sidewalks, paving, and such general information as can be of use. This size is for wall purposes.

A second size is made up on a scale of 100 ft. to the inch and each sheet contains one quarter-section, making the size of the sheet 26x26 in. On this map, in addition to data on the larger maps, are sewer wyes, sewer connections, water-main connections, valves, shut-off boxes, hydrants, paving, openings in paving and date made, cost of special improvements against each lot, sidewalks, new buildings, the lighting system and a great deal of minor data connected with the above. At present none of these data is collected in a compact form that can be used to any advantage and in that respect this department has not been kept up to the needs of the city. In no other way can such information be kept available for instant use than by progress maps. This work has taken a great deal of labor and painstaking research and when completed will form one of the most valuable records in the office.

There are no more valuable records in any engineer's office than progress records and maps, and this applies with great force to the work of municipal engineering. Data on work constructed and completed are wanted at all times by a great many people in all lines of business. Some desire data for mere curiosity; but the great majority want them because their business is more or less affected by such information. In many cases the health and safety of the public depend on the absolute correctness of the data. It seems a foolish policy for an office not to make a record of work done at the time it is done, when oftentimes such record can be correctly made at a small cost, when if left undone irreparable damage may follow. We have daily calls for information, that we should be able to give and that it is the function of the city to provide to its citizens, that cannot be given because of lack of records. It is the aim to eliminate this state of affairs as rapidly as is possible. The data must be picked up in all manners of ways and time is the greatest factor in its completion.

The lack of records in the office is an unfortunate condition that has hampered our work greatly during the past two years. Efforts to remedy this defect have in some cases proved effectual, but in other cases there is no remedy whatever. As such may be mentioned lack of actual cost of contract work, time when certain contracts were begun, progress of same and time of completion; surveys made, results and conclusions; location of monuments, opening in streets, street lines, grades for sidewalks and streets and data upon which made; data upon which sewer and water mains have been designed, and cost of office work.

A complete office system has been started in order to eliminate these defects in the records. The loose-leaf system is used throughout. The lack of notes on surveys, time the men were employed on any piece of work and sidewalk records, was most noticeable and this has been remedied. The loose-leaf system of field notes was adopted, and a filing system is used which I have every reason to believe is original. The field-note sheets are 4¼x7¼ in. These sheets are pasted on 5x8-in. division index cards which have the usual 5-cut tab. On this tab the character of the work is printed and the indexing completed. The time of men employed and any class of work is kept in a similar manner.

For the purposes of engineering the records of costs have been divided into heads as follows: Board of Health; Bridges; Dam; Maps; Monument Lines; Office Supplies; Park Commission; Paving; Pay Roll; Requisitions; Sewers; Street Grades; Street Lines; Water-Works; Water Mains and Sidewalks. Each of these is subdivided into two heads: (1) Construction, and (2) Maintenance. Each of these subheads is subdivided again into Labor, Material; Engineering; and Estimates.

Letters to the Editor

A Defense of Steel Barges

Sir—In your issue of Aug. 29, 1912, there appears an article by A. E. Hageboeck, under the caption, "Steel vs. Creosoted Wood for River Barges." This article makes the steel barge compare very unfavorably with the wooden barge. The author states that a steel barge 100 ft. x 20 ft. x 4 ft. 7 in. costs more than three times as much as a barge of the same size constructed of untreated wood.

The following abstracts from bids received within the last year or two by the United States government engineers at Wheeling, W. Va., and at St. Louis, Mo., show that the actual figures submitted in competition do not agree with Mr. Hageboeck's statement. The following is an abstract of proposals opened at Wheeling, W. Va., Nov. 23, 1911, by Major F. W. Alstaetter, Corps of Engineers, for furnishing and delivering two gravel barges 100 ft. x 22 ft. x 5 ft. for Dam No. 28, Ohio River.

Bidder No.	Rate per barge	Amount	Material
1	$3680	$7340	Untreated Wood
2	2950	5900	Untreated Wood
3	4350	8700	Steel
4	3870	7740	Untreated Wood
5	3050	6100	Untreated Wood
6	3620	7240	Untreated Wood

This shows a ratio between the cost of a steel barge and a wooden barge of 1.47 to 1, in comparing with the lowest price received for a wooden barge, and a ratio of 1.27 to 1 when averaging all the bids for wooden barges.

Bids were also opened by Major Alstaetter on Jan. 24, 1912, for furnishing and delivering two dump scows, 80 ft. x 21 ft. x 6 ft. 4 in., for Dam No. 26, Ohio River, as follows:

Bidder No.	Rate per barge	Amount	Material
1	$6490	$12,980	Untreated Wood
2	6565	13,130	Untreated Wood
3	5895	11,790	Untreated Wood
4	6700	13,400	Steel

The ratio between the price of a steel barge and the lowest bid received for a wooden barge is 1.14 to 1. The ratio of cost between the steel barge and the average of all bids received for wooden barges is 1.06 to 1.

The following is an abstract of proposals for flat barges 55 ft. x 16 ft. x 3 ft., opened by Major Charles L. Potter, Corps of Engineers, at St. Louis, Mo., Oct. 7, 1910:

Bidder 1—Lowest bidder for steel flat boats. $1725 each.
Bidder 2—Lowest bidder for wooden flat boats. 1223 each.

The cost ratio of steel flat boat to wooden flat boat is 1.41 to 1.

It will be seen from the above abstracts that the cost of wooden barges of the foregoing types and sizes at this time (not "in the early 90's") is about 75% of the cost of steel barges of the same type and size, and not 30%, as Mr. Hageboeck's article indicates.

There are a number of other parts of Mr. Hageboeck's article to which exception could be taken, but as the writer has shown that Mr. Hageboeck is in error in the foundation of his argument in favor of wooden barges, no further comment is deemed necessary.

JOHN L. TAYLOR.

Oakmont, Penn., Sept. 5, 1912.

Concrete Pile Failures: Causes and Remedies

Sir—Your issue of Sept. 12 contains an article on defective concrete piles, from information furnished by the Superintendent of the Bureau of Buildings for the Borough of Manhattan, New York City.

The writer, as an engineer, has used a large number of concrete piles, has been frequently employed as consulting expert where they were contemplated, has contributed to the columns of ENGINEERING NEWS on the subject, and has made an exhaustive study and search into every detail of the various systems in use.

In the practice of my profession as an engineer and architect, I have repeatedly noted that in the use of concrete piles, the first consideration is always one of cost, except in the rare instances where only concrete piles can be used, as in the instance of the subway tunnels to Brooklyn.

When it is established that a saving in cost will be involved by their use, the next step is that of obtaining a price for placing concrete piles, and here the fatal mistake is too frequently made of not going into the question of the adaptability of a specific system to the conditions existing where it is to be used.

It is not desirable to condemn a system for the reason that it developed into a failure upon some particular piece of work. Under proper conditions, the same system might be found to prove perfect; and, as a general thing, the various failures can be traced to this very fact.

The question of shape, whether tapered or straight, the manner of driving, whether by hammer or jet, the question as to whether the pile will be cast before or after driving, and various other questions, must be decided not upon cost, except in comparison with timber piles, but upon the conditions existing at the site of the work.

It should be seriously questioned whether or not the attempts to deviate from a straight pile, both as to the forcing of a bulb at the bottom or tapering the pile, are correct in principle. I have gone deeply into this question, and my calculations, as well as experiments, lead me to believe firmly that any such attempts are wrong and do not add to the value of the pile.

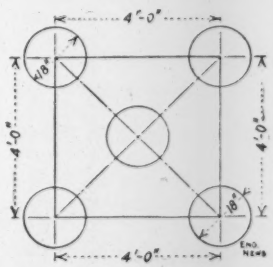
I covered this question as to tapered piles in ENGINEERING NEWS of Feb. 25, 1909, so I make no additional reference to that type here. The pile mentioned in the article in the Sept. 12 issue has come into such general use as to warrant a word pertaining to it.

I assume that every engineer strives to so distribute foundation loads as to feel reasonably certain that any possible settlement will take place without the resultant concentration of an upward thrust at any part of the work. This means that every pile must have, as nearly as possible, a known load capacity. The load capacity will depend upon two things, the displacement of the pile and its frictional area. I am not here considering piles acting as columns when driven to hardpan or rock.

The estimated load capacity will be fixed by some formula, possibly by previous test, in either case the calculation involves the depth of penetration under a certain weight falling a certain distance. If the piles are driven to a required penetration, up to this point we assume to know their load capacity, which is, up to this time, fixed by the displacement and frictional area of the pile and the degree to which it has been driven.

If at this stage, we force a shape on the point of the pile, unless we know the precise shape and volume of the bulb, we are in complete darkness as to whether we have added a known additional load capacity or not, because we cannot know its frictional area.

Now, at the point of the pile, where the natural compression of the ground is greatest over the length of the pile, this



is a serious factor, since while it may add to the bearing value, we do not know how much it destroys the previous calculation for load capacity, and the additional factor of strength is turned into one of uncertainty. That such a bulb could be formed without knowledge of the exact conditions at the point of the pile, so that it would have a known frictional value with the surrounding earth and also a known shape, I regard as improbable.

The use of concrete piles cast in the ground without employing a protecting form till the concrete has hardened, as in the instance already referred to, should be confined to situations where the ground will retain its shape by reason of its being clayey, not fluid and not under great compression from superimposed loads. It should also be known that its texture is such as not to slide under the compression due to driving adjacent piles. The spacing of the piles on centers would largely enter into this consideration. Otherwise the concrete will become distorted as in the case mentioned.

Assume that such a pile is driven in fluid mud, diameter of pile 18 in., depth of penetration 30 ft., weight of wet concrete 145 lb. per cu.ft., weight of mud 130 lb. per cu.ft., and the spacing of the piles on centers as shown in the accompanying diagram.

We have, disregarding any pressure from superimposed loads on surrounding ground, at the point of the pile natural ground compression of 3900 lb. per sq.ft.; increased ground compression due to displacement of 3.534 cu.ft. in 16 cu.ft., 22.09%, or 861.5 lb. per sq.ft.; total compression of ground per sq.ft., 4761.5 lb.; compression on wet concrete, 4350 lb. per sq.ft., making a difference in compression per sq.ft. between the concrete and surrounding earth of 411 lb. per sq.ft.

Over the entire circumference of the pile for 1 lin.ft. of its length at its point, we have, therefore, a pressure of 1936 lb. upon the wet concrete over and above the pressure it is exerting to counterbalance distortion. This means that the value of the pile is unknown and dependent upon a load test to establish the load that may safely be placed upon it.

I invite the attention of Mr. Miller to these facts as suggestive of the necessity for amending our building code.

C. S. HOWELL.

1182 Broadway, New York City,
Sept. 17, 1912.

Standard Tests of the Efficiency of Sewage Treatment

Sir—The subject of Mr. Hoover's article in your issue of Sept. 7 is most important. A lot of work has been and is being done, in the way of making tests of sewage plants, that is interesting to the chemist, but of little value to the engineer in designing and to the superintendent in operating the plant.

There can be no question but that there should be, as Mr. Hoover suggests, some uniform method of testing, so that results at different works would be comparable and thus assist in improving them.

Secondly, there can also be no question but that the tests should not only give results, helpful to understand the operation of plants under different conditions, but they should be obtained in the simplest manner possible and limited to the practically useful data so far as the regular routine work is concerned. Analyses differ on different plants according to the process and purpose of purification. Thus, the most desirable tests may not be the same, if made for an intermittent filter plant, for sprinkling filters and for dilution disposal with its various degrees of required treatment, and the analyses should besides clearly indicate the effect of each part of the treatment.

Thirdly, in establishing standard tests a clear distinction should be made be-

tween the treatments for "sanitary" and "esthetic" purposes, or as to whether the main object is to prevent disease or nuisance. For some plants the sanitary treatment may be the only necessary one and the tests thus limited, because they would probably in most cases eliminate any further test for a possible nuisance. For some other plants tests to guard against a possible nuisance might alone be sufficient.

Fourthly, we should pay more attention than formerly to the question of suspended matter, including the resistant and non-resistant or unstable organic matters, to the "settleable" matters, settling within a given time and at different velocities of flow, to the fats and sulphur compounds, etc.

Fifthly, more definite and simple methods should be established, to get the complete effect of dissolved oxygen upon various kinds of sewage particles, resistant and non-resistant, solid and liquid, its absorption by the liquid from the air and from plants; and its disappearance from the liquids through decomposition of unstable organic matter.

Sixthly, a better distinction should be made and the importance established of tests referring to colloidal matter, and the latter should be given an exact definition.

There are a number of other matters that would also be advanced by discussion at this time and Mr. Hoover's suggestion regarding "getting together" on this question is timely and should be highly commended.

RUDOLPH HERING.
170 Broadway, New York City,
Sept. 12, 1912.

Sir—Ever since I have had the opportunity to study the methods in use at sewage-purification plants it has occurred to me that too much time is wasted with determinations of little value in the control of a plant. Mr. Hoover's statement, that the determination of the volatile suspended matter, as a routine procedure, is of little significance, is in my opinion correct. The reason for this is apparent. Organic matter is not of uniform composition and therefore not of uniform oxidizability. For instance, protein matter will break down quickly, while carbonaceous matter, such as cellulose originating from paper, rags, etc., is likely to remain undecomposed for a longer period. All these constituents are determined as volatile suspended matter and so we cannot expect this result to bear any relation to the putrescibility test. The bacterial results, too, are in my opinion of little value unless the purification has to be carried to the extreme in order to protect a water supply. Ordinarily, the bacterial content will fluctuate with the quantity of suspended matter present. The bacterial count is surely superfluous as far as the preliminary purification devices are concerned.

Where biologic treatment is resorted to, the determination of the nitrogenous constituents is of importance, particularly the termination of the nitrites and nitrates. No test, however, will reveal the work accomplished in a sewage-purification plant as readily as a biologic test, such as the methylenblue test in combination with the dissolved oxygen determination. Just as the weight of importance in water analysis has gradually shifted from the chemical constituents to the bacterial content, so have we come to recognize the superiority of biologic control to determinations of chemical constituents by artificial means. The importance of such biologic tests has been recognized for years. The old German "Sauerstoffzehrung" test is in agreement with such a principle. I think Mr. Hoover ought to be commended for his attempt to stimulate the interest of sewage chemists to work along similar lines. He neglected to mention, however, the incubation method and formula employed by Prof. Phelps (Report of Col. Wm. M. Black, U. S. A., and Prof. E. B. Phelps, "Concerning Location of Sewer Outlets and Discharge of Sewage into New York Harbor, 1911," Board of Estimate and Apportionment) by means of which one can obtain fairly close information as to the necessary dilution of an effluent in a certain stream at a given run.

Our aim in sewage disposal is to improve the liquid from a dilution standpoint and if we can gain knowledge of such improvement by simple biologic tests we have reached an *ideal method*. There are still various shortcomings in the methods spoken of, which will have to be overcome. One drawback is that for various sewages or effluents a condition factor must be introduced into Phelps' formula in order to make the results coincide when different dilutions are employed on one and the same liquid. Another difficulty with which I have lately become impressed is that one cannot make enough tests during the day in a running plant to gain an absolutely definite idea of what has been accomplished from a dilution standpoint. One skilled chemist may be able in an eight hours' working period to make 15 to 20 tests, which is not sufficient considering the small sample required for incubation. Composites cannot be made without danger of losing some of the initial oxygen and the use of preservatives is, of course, out of the question. Furthermore, such a control cannot be carried on during the night unless an experienced chemist is at hand. The method itself as well as the manual labor involved are simple, yet one must be very careful to avoid aëration in making the dilutions or the results are likely to be misleading.

No doubt, a method such as the one described will ultimately replace meaningless chemical methods. As far as the methylenblue test is concerned it is the one test which is readily available to sewage-works managers and the result of which is of real practical value.

I have had on previous occasions a chance to express my preference for an incubation period of 20° C., this constituting a temperature closer to the one at which the biologic processes of surface waters take place. At such a temperature the use of tight-fitting stoppers without the aid of seals is sufficient.

Mr. Hoover's suggestion to form a national association of sewage analysts, sewage-works managers and others, interested in this field, is a good one, but I doubt that an organization of sufficient strength to be of real importance can be built up. At present there is only a comparatively limited number of people ready to join such a specialized organization, and it takes considerable financial support to publish a technical journal. It strikes me that since the American Public Health Association has formed a sanitary-engineering section, which has its first session this month, the standardization of methods of analysis and discussions on matters relating to sewage disposal would find an opportune place in that section. The *Journal* of the American Public Health Association and the standard engineering journals are read by all of the people who would be likely to join such a proposed society. Those journals are always glad to receive contributions relating to improvements in sewage disposal.

ARTHUR LEDERER,
Chemist and Bacteriologist,
Sanitary District of Chicago.
39th St. and Lake Front,
Chicago, Ill., Sept. 10, 1912.

Notes and Queries

Bearing Values for Inclined Cuts. An unfortunate typographical error in the letter of Roland P. Davis, printed in our issue of Sept. 5, 1912, distorted the meaning somewhat. In the second paragraph, the first sentence should read:

> At the outset he misquotes Prof. H. S. Jacoby's formula when he states that p and q represent, respectively, the normal intensities on the end and across the fibers, when as a matter of fact they represent the allowable or safe normal intensities. From this it follows that the value of n as given by Professor Jacoby's formula is not independent of the physical properties of the wood.

The last part of this sentence was mutilated by the accidental omission of two lines of type.

In the letter of Mr. John Wilkes published in our issue of Sept. 5 three ciphers were omitted from the statement as to the estimated cost of constructing reservoirs on the head waters of the Mississippi River to store its floods. The correct estimate of the cost, therefore, is $1,300,000,000.

The plans for the sewage treatment works for Orange, East Orange and Montclair, N. J., mentioned on p. 462 of our issue of Sept. 5, 1912, as having been approved by the State Board of Health of New Jersey, should have been credited to the firm of Hering & Gregory instead of Hering & Fuller.

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Engineering News

Those who are against the force account or day-labor system of doing municipal work will be pleased with the following paragraph from the *Evening Telegraph* of Alton, Ill. (Sept. 2, 1912):

Mayor Faulstich has declared himself unequivocally in favor of doing all city work on the streets under the contract system, after giving the day-work system a tryout in repairing damages done by the cloudburst of July 14. The day's-work system has not proved satisfactory in any way and has been a great disappointment to the mayor and to the street department of the city.

A correspondent supplies the following additional evidence: "Both teams and men 'soldiered' shamefully. It was all emergency work."

No data are available as to the efficiency of the city government of Alton in supervising either day-labor or contract work. If there was a lack of such efficiency then the poor results at Alton should not be charged wholly to the day-labor system.

The New Oil Motor Ship "Christian X"

A notable event of the past week in marine engineering circles was the arrival at the Port of New York of the new Hamburg-American oil-engine ship "Christian X," a sister ship to the famous "Selandia" and built like her by the firm of Burmeister & Wain, of Copenhagen, Denmark. After completion the vessel was purchased for the Hamburg-American Line, which invited a number of prominent engineers of New York City to visit the vessel on her arrival in port. The "Christian X" is by far the largest vessel equipped with oil engines which has ever arrived at the Port of New York, or indeed on this side of the Atlantic. She is 370 ft. in length with 53 ft. beam and a displacement of about 9800 tons. She is propelled by twin screws, each of them driven by an 8-cylinder 4-stroke-cycle Diesel engine. Her visit to New York was to fill her fuel tanks with oil, she being en route from New Orleans to Europe with cargo. It is of interest to note that while her oil consumption is about 10 tons per day, the fuel tanks have a capacity of nearly 1000 tons. As her speed is 11 to 12 knots, she can, if necessary, sail entirely around the world without taking on a fresh supply of fuel, and is thus able to procure her oil where the market conditions are most favorable. Lack of space in our present issue compels us to postpone until next week a fuller description and illustrations of the vessel.

Autobobile Speed and Highway Location

The current practices in road layout, established during the last century, are based on the requirements of horse-vehicle traffic. Today, with automobile traffic, certain of these practices require revision. The speed of the motor vehicle demands easing the curvature to an extent approximating railway practice rather than established road practice.

We have recently noted a new road destined to be used largely by motor vehicles, in which occurs a succession of curves and reverse curves averaging not much over 100 ft. radius, and this, too, under topographic and land conditions which would have made it easy to avoid the dangers of sharp curvature. In the case noted the sharp curves even occur at the foot of a hill, where maximum speed is most likely. It is cases of this kind that suggest the need of more attention to the matter of curvature in roads which will carry motor traffic to an appreciable extent.

It would be unnecessary to refer to the subject here were it not for the fact that road construction, and in the case of new roads of short length or minor character also the location or layout of the roads, is largely done on a purely practical basis; that is to say, without the coöperation of men trained in engineering principles. The practical man, whether road builder or not, has distinctly less appreciation of curvature in the railway sense than the engineer. Yet it is precisely in this sense that curvature is important on motor-vehicle roads.

The subject of banking or superelevation must be applied to roads in the same way as the subject of curvature, i.e., in the railway sense. The automobile in its progress does not differ materially from the railway vehicle in gage, speed, or liability to high-speed accident. The latter point, indeed, is only too evident in the daily accident news. There is a further factor in the case of the motor vehicle, namely the crown of the roadway: the likelihood that the vehicle will be on the outer side of the roadway at the time it is operating on the shortest radius of curvature calls for extra allowance in proportioning the transverse slope of the roadway as a whole.

It is by no means uncommon to see curves in roads which, on any proper calculation, would require a transverse slope of 2 to 4 ft. in their width, built with either no banking whatever or with banking so small that the upper half of

the road is level or slopes down to the outside of the curve. The danger of such construction is plain enough.

These conditions call for the establishment of more precise rules for roads destined to carry automobile traffic than now exist. No less necessary is the proper dissemination of the information given by these rules, in order that they may speedily become embodied in empirical road-building practice.

Federal Legislation in Aid of Road Improvement

In response to the agitation for federal appropriations in aid of highway construction, Congress before adjournment tacked on a rider to the Post Office appropriation bill, establishing a Congressional Commission to investigate the general subject of federal aid to road construction. It also appropriated $500,000 for improving roads used by rural free delivery carriers, to be expended under the joint direction of the Secretary of Agriculture and the Postmaster-General. This federal appropriation, however, is only to be spent in localities where the state or the locality in which the improvement is made will contribute a sum equal to double the contribution from the National Treasury. The full text of this clause of the act is printed in a foot note below.*

The Commission appointed to investigate the subject of federal aid to road construction in accordance with the act is made up as follows:

From the Senate:

Hon. Jonathan Bourne, Jr., of Portland, Ore.
Hon. Boies Penrose, of Philadelphia, Penn.
Hon. Asle J. Gronna, of Lakota, No. Dak.
Hon. Claude A. Swanson, of Chatham, Va.
Hon. Lee S. Overman, of Salisbury, N. C.

From the House:

Hon. Dorsey W. Shackleford, of Jefferson City, Mo.
Hon. Gordon Lee, of Chicamauga, Ga.
Hon. Daniel J. McGillicuddy, of Lewiston, Me.
Hon. Martin D. Madden, of Chicago, Ill.
Hon. Robert W. Austin, of Knoxville, Tenn.

If the $500,000 appropriation is divided equally between all the states, it would give each state $10,000, or about enough to build a mile or less of first-class bituminous macadam road. Rural free delivery routes, however, are chiefly in the farming districts where dirt roads alone exist; and an expenditure of $500 to $1000 a mile would generally be sufficient to build a fair sand-clay road or a gravel road. If a still more primitive grade of road will be accepted as satisfactory and the money is to be devoted to road dragging, draining and similar work, with no attempt to apply a special surfacing material to the road, then the appropriation might be sufficient to cover the rural free delivery roads in a single township, used by two or three carriers.

Of course, the appropriation will be multiplied by three, since the locality where the road is built must contribute two dollars for every one from the National Treasury; but even so it is evident that if the law is to be complied with by so using the money as to benefit the roads enough for the carrier to actually travel farther and more regularly and thus effect a "saving to the government," then the money must be spent in a very limited district.

It appears that the Secretary of Agriculture and Postmaster-General are to constitute a sort of second commission on federal aid of road construction, and are to report their conclusions to congress within a year, with the results obtained from the half-million-dollar appropriation.

The public has doubtless to thank some of the conservative and level-headed members of Congress that the workers for federal appropriations for highway construction did not stampede that body into taking ten times or fifty times as much from the treasury as a starter. To refer the whole matter to a commission for investigation and report was doubtless the wisest way to meet the widespread demand that legislation of some sort in aid of good roads should be enacted before adjournment of Congress.

* That a joint committee shall be appointed, composed of five members of the Senate to be designated by the chairman of the Senate Committee on Post Offices and Post Roads, and five Members of the House to be designated by the chairman of the House Committee on the Post Office and Post Roads, to make inquiry into the subject of federal aid in the construction of postroads and report at the earliest practicable date, and for this purpose they are authorized by subcommittee or otherwise to sit during the sessions or recess of Congress, at such times and places as they may deem advisable, to send for persons and papers, to administer oaths, to summons and compel the attendance of witnesses, and to employ such clerical, expert and stenographic assistance as shall be necessary, and to pay the necessary expenses of such inquiry there is hereby appropriated out of any money in the Treasury not otherwise appropriated the sum of twenty-five thousand dollars to be paid out upon the audit and order of the chairman or acting chairman of said committee:

Provided, That there is hereby appropriated the sum of $500,000, out of any money in the Treasury not otherwise appropriated, to be expended by the Secretary of Agriculture in coöperation with the Postmaster General in improving the conditions of roads to be selected by them over which rural delivery is or may hereafter be established, such improvement to be for the purpose of ascertaining the increase in the territory which could be served by each carrier as a result of such improvement, the possible increase of the number of delivery days in each year, the amount required in excess of local expenditures for the proper maintenance of such roads, and the relative saving to the Government in the operation of the Rural Delivery Service, and to the local inhabitants in the transportation of their products by reason of such improvement and report the results in detail to Congress:

Provided, That the State or the local subdivision thereof in which such improvement is made under this proisvion shall furnish double the amount of money for the improvement of the road or roads so selected. Such improvement shall be made under the supervision of the Secretary of Agriculture.

That the Secretary of Agriculture and the Postmaster General are hereby directed to report to Congress within one year after the ratification of this Act the result of their operations under this Act, the number of miles of road improved, the cost of same, and such other information as they may have acquired in connection with the operation of this Act, together with such recommendations as shall seem wise for providing a general plan of national aid for the improvement of postal roads in coöperation with the States and counties, and to bring about as near as possible such coöperation among the various States as will insure uniform and equitable interstate highway regulations, and for providing necessary funds for carrying out such plans of national aid, if it shall be deemed feasible to provide the same or any part thereof otherwise than by appropriation from the Treasury for that purpose.

The Irondequoit Creek Disaster on the New York Barge Canal and Its Bearing on Current Waterway Agitation

In our last week's issue we gave much space to a full description of the recent bad break on the New York Barge Canal near Rochester, N. Y. As we there recorded, a section of the canal which is carried across a broad valley on an embankment some 60 ft. in height suddenly began to leak. As the embankment was rapidly eroded, the concrete-lined trough which constitutes the canal channel was undermined, settled and gave way and in a few minutes' time a gap over 500 ft. long had been made in the canal and in the embankment which supports it.

This occurrence is of much interest to engineers as a notable instance of the failure of a piece of engineering work which was apparently planned and executed with exceeding care. We do not propose at this time to discuss particularly the causes of the failure, nor the lessons they may contain to the engineering constructor. What we now wish to do is to point out the object lesson which such a disaster ought to furnish to those who are engaged in a campaign for inland waterway construction.

In the discussion of the relative merits and relative economy of waterway and railway transportation, hardly anything has been said, so far as we recall, with reference to the relative *reliability* of the two systems of transportation. The Irondequoit Creek disaster, however, furnishes an instructive illustration of the *vulnerability*, if we may so term it, of any inland canal.

Those of our readers who studied the photographs and drawings of the disaster in our last issue can readily see that the repair of this huge break is no short job. A more or less defective culvert which carried Irondequoit Creek under the bank must be rebuilt in a substantial manner and then the fill must be made over it to a height of fully 60 ft. and extending for a distance of 600 ft.

A very puzzling problem indeed is to know how this fill may be compacted sufficiently so that it will be safe to build the canal trough across it when it is completed. There will inevitably be some

settlement in a fill of such height, even if it is made with as much care as an earth dam. If settlement occurs in this new work where it joins onto the old, there will be great danger of a break in the canal lining and another leak, with renewed disastrous results.

Every experienced engineer knows that there is all the difference in the world between building an embankment to carry a railway track and building an embankment to hold water. This is not saying that safe and substantial canal embankments cannot be built, but the building of them is not a job that can well be hurried. If a break 500 ft. long occurs in a railway line through a landslide or washout or other disaster, it is taken as a matter of course that the break will be repaired within a few hours, or at most a few days, by at least a temporary track so that trains can be run across it. But no such quick repair is possible in the case of a waterway, no matter how great the ingenuity or ability of the engineers in charge. They are dealing with an entirely different material and with different conditions.

Let us suppose—and it is not a difficult supposition—that the New York Barge Canal were now actually completed for its whole length and that it were carrying something like the volume of traffic which its projectors fondly hoped it would attract. It may also be supposed that in a season of bountiful crops like the present the channel would be crowded with vessels carrying Western grain through to tidewater before the close of navigation. But now at the beginning of September, along comes such a break as has just happened at Irondequoit Creek crossing and the canal is put out of business, not for a few days but for several weeks, or very likely for all the rest of the shipping season. It is not saying too much to say that a method of transportation which is subject to such vicissitudes is under a very great handicap when it attempts to compete for business under modern conditions.

It may be said, perhaps, by the strenuous advocates of waterway construction that when a canal is once completed, if it has been well built by competent engineers, it will not be subject to such serious breaks as that which has just occurred near Rochester. Experience, however, does not at all bear out this assumption. A canal is just as liable to be interrupted by accident as a railway line. The accidents are perhaps fewer, but they are more serious and take longer to repair when they do occur.

What we say, moreover, applies to inland navigation on rivers which have been improved by slack watering as well as to artificial canals. Floods will come and destroy dams which have been supposed to be entirely secure and will injure locks; vessels will come to grief and obstruct narrow channels; droughts of unprecedented length will occur and cause deficiency of water supply.

Of course navigation on inland waterways throughout the greater portion of the United States is stopped during a large part of the year by ice anyway. It is our purpose here to point out merely that besides this annually recurring obstruction, an inland waterway is far more liable to interruption and less reliable in rendering necessary public service than the railway.

There is another aspect, in which the Irondequoit Creek disaster serves as a useful reminder and that is as to the cost of maintenance of waterways. It is too often assumed by waterway promoters that when a waterway, whether it be a canal or an improved river, is once completed, expenditure upon it is at an end and that it will not require the heavy annual outlay for maintenance that is required on a railway. To engineers it is probably unnecessary to say that this is a fallacy. If the structures on a canal or on a slack-watered river are not properly maintained and looked after, their failure with attendant destruction is practically certain to occur. It is true that there are many items in a railway maintenance-of-way account that do not occur on a canal, but contrawise, the maintenance of a canal involves a great many items which never occur on a railway.

Of course it is well understood that the State of New York has now advanced far toward completion with its barge-canal enterprise, and has nothing to do but to go ahead and complete it and allow experience to determine what traffic it can obtain and what burdens it will place upon the taxpayers of the state in the way of maintenance. The promoters of other huge inland-waterway schemes, however, will do well to wait and see the results of New York's experiment before venturing further millions on similar schemes.

The Bursting Pressure of an Earth Fill

The photograph reproduced on the first page of this issue of ENGINEERING NEWS, showing an accident to a retaining wall which occurred a few weeks ago in St. Louis, with the accompanying description of the circumstances in connection with the failure, seems to teach an instructive lesson which may be of value to a good many engineers and contractors. Notwithstanding all that has been written and printed on the subject of earth pressure, the average man who has to do with construction, we fear, does not fully appreciate the magnitude of the forces which are exerted in this way.

To a large proportion of the engineering profession, doubtless, no warning is needed as to the wisdom of making thorough provision for the forces exerted by confined earth or grain, or sand, or coal, or other granular material. Our suggestions here are intended, therefore not for those who know, but for those who do not know, or who if they know do not fully realize.

A great many walls are being built nowadays in all parts of the country which no engineer of any sort has a hand in designing and it is frequent to see such walls only a foot or two in thickness expected to withstand the pressure of a fairly high bank of earth. To the average so called practical man such a wall looks all right and he argues in the usual way that it is all the wall the owner can afford to pay for. Further than that he sees a bank of unsupported earth standing year after year with nearly vertical face and he thinks the earth behind the thin wall which he builds is going to do the same thing.

There is another sort of construction which is becoming rather popular in these days and which has something to be said in its favor, and that is the use of earth to replace concrete in the interior filling of structures which rely chiefly upon their weight to do their work. The retaining wall in St. Louis whose failure is recorded in this issue was an example of this class of construction. The origin of this design is due, of course, to the facility with which concrete and especially reinforced concrete, can be built and made fairly substantial in comparatively thin masses. There is, of course, a large saving if the pier or abutment can be built as a hollow shell and its interior filled with earth instead of making it one solid mass of masonry.

We do not condemn this class of construction. It has a proper field and a very useful one; but we wish to sound the warning that where an engineer determines to adopt a design of this sort he should make sure that his supporting walls are strong enough to withstand the pressure of the confined earth.

And this gives rise to the interesting question what is the pressure of confined earth, be it clay, sand, gravel or what not, used for filling the interior of such structures. We do not here propose to enter into any long and abstruse discussion of the voluminous treatises which have been written by engineers on formulas for earth pressures. A very large part of it is far over the head of those engaged in practical work who most need to make use of it. It must be said of a very large part of it, further, that it partakes of the nature of aiming at an exact determination of what cannot possibly be determined with any more than rough approximation.

We therefore wish to suggest a very simple rule for roughly computing earth pressure, a rule so simple that any layman can understand it if he has even a

slight knowledge of constructive principles.

We do not mean that this rule should take the place of ordinary and usual methods used by engineers in proportioning retaining-walls, but rather that the engineer should keep it in his mind as a practical guide in construction, in the many cases where no computation is made.

The rule we propose is that the pressure of earth against a wall or other confining structure should be understood to be *at least* as great as the pressure of a mass of water of two-thirds the depth. In other words, a retaining-wall should be at least as strong and as thick at the base as if it were a masonry dam of two-thirdsthe height. This rule is free from all the pitfalls of mathematics and it is a rule which may engineer or near-engineer can easily understand and remember.

If the engineer is competent to compute earth pressure by more accurate methods, by all means let him do so. Our proposed rule is designed to help the man who does not realize what earth pressures mean, even when they are reduced to figures.

It should be particularly noted that we have said that the wall should be *at least* as thick as it would be if it were a dam sustaining the pressure of water two-thirds as deep, for there are unquestionably cases where the material behind a retaining wall will exert a heavier pressure than this.

Of course in the case of some structures it may not be thickness that is demanded, but ample staying to resist the bursting pressure. The St. Louis wall, for example, would probably have stood intact if the cross-walls, which tied the front and back walls together, had been put in at 10-ft. intervals instead of 20-ft. intervals.

Very likely it may be objected that the above rule is altogether too severe and would lead to needless expense in structures which have to sustain earth pressure. We do not think this objection will be made, however, by any engineer of large experience who has given careful study to the behavior of structures which have resisted earth pressure for a long time.

It will be remembered that the general rule of the elder Trautwine for proportioning retaining walls was to make the base equal to four-tenths of the height. A structure of such proportion is a pretty good gravity dam with the pond behind it two-thirds full. It is a fact also that if one travels about the country and carefully observes retaining walls built by good engineers, which have been standing for a considerable period of years, he will find a considerable proportion of them, even those built with what would generally be considered generous dimensions, which have bulged or tipped considerably from their original position. This is particularly true in sections where frost has opportunity to get in its work behind the wall.

It will be understood, of course, in this discussion that we are speaking of structures intended to be permanent. For temporary structures, such as walls of a contractor's coffer-dam, for example, one is justified in going much closer to the margin of safety, so long as reasonable care is taken to safeguard human lives. Even in such work, however, it is a useful thing to bear in mind as one looks at the struts sustaining the sheeting at the side of a deep ditch or at the walls sustaining the fill inside a coffer-dam, that the mass of dirt which one sees is exerting as much pressure, probably, as if it were water two-thirds as deep.

Annual Convention of the New England Water Works Association

The thirty-first annual convention of the New England Water Works Association was held at Washington, D. C., Sept. 18 to 20. About a hundred active members were present, and a larger number of associate members and guests. A half dozen papers were presented at the three sessions; most of these related to state control of dams and reservoirs, of water-power development and of public utilities. A notable feature was a volunteer paper by T. Chalkley Hatton, of Wilmington, Del., in which he made his first formal public statement regarding the failure of the dam at Austin, Penn., in September, 1911. It will be remembered that Mr. Hatton was the engineer for this dam.

State Control of Dams and Reservoirs

CONNECTICUT—Control over the design and construction of dams and reservoirs, with special reference to actual practice in the eastern part of the state, was treated by Charles E. Chandler, of Norwich, Conn. The paper was based on the experience of the author as an independent engineer and also (beginning in 1891) as a member of the Connecticut State Board of Engineers, having supervision of dams and reservoirs. Two important sections of the Connecticut statute, passed in 1878, are as follows:

APPROVAL OF DAMS—Before any person or corporation shall construct a dam or reservoir in a locality where life or property may be endangered through insufficiency thereof, the plans and specifications for such dam or reservoir shall be submitted to a member of said board of civil engineers, who shall examine the ground where the dam or reservoir is to be built and the plans and specifications therefor; if he approve the same, he shall issue a certificate authorizing the construction of such dam or reservoir. No such dam or reservoir shall be constructed without such approval and certificate.

INSPECTION OF WORK; CERTIFICATE OF APPROVAL—The engineer under whose authority a dam or reservoir is being constructed shall inspect the work or cause the same to be inspected at least three times before completion; and if he shall be satisfied that such dam or reservoir has been built in a substantial and safe manner, in accordance with the plans and specifications approved by him, and is strong and secure, he shall issue a certificate approving the same, which certificate shall be recorded in the office of the town clerk of the town in which such dam or reservoir is located. No such dam or reservoir shall be used until such certificate is obtained and recorded.

The practice of Mr. Chandler, as a state engineer of dams, has been to let those who proposed to build small dams come to him, choosing between state approval or the risk attendant on building without approval. When plans were submitted, attention was first given to the spillway in relation to the tributary drainage area, Fanning's rule being the general standard, subject to modification to suit local conditions. Spillway masonry sections were required of such dimensions as would "bring the resultant within the 'middle third' of the base, with the water at level of top of abutments and with no water downstream from the dam." When Mr. Chandler had confidence in the owner and builder of the dam and inspectors were constantly on the work, he made five inspections: one of the site, three during construction and one after completion. Under less favorable conditions he made more frequent visits, up to two or three a week in one case. The author's summary of his 23 years' experience as practicing engineer and as state supervising engineer, during all of which some 25 dams were observed, follows:

When plans, specifications and inspection are under the supervision of competent engineers in the employ of the owner, state control is merely nominal.

When engineers are inexperienced in dam building they generally cheerfully modify their plans at the request of the state engineer, but not always.

When the owner depends on the contractor for his engineering, as well as when an inexperienced engineer is employed, the work of the state engineer has been very important.

In the opinion of the writer the law has done much good in Connecticut, but it is deficient in many respects, among which are the following:

(1) There is no provision for a hearing of interested parties.

(2) There is no provision for filing plans, specifications, so that anyone can tell how a dam is to be or has been built.

(3) The state engineer cannot take the initiative in the case of unsafe dams already built.

PENNSYLVANIA—A paper by Prof. Frank P. McKibben, of Lehigh University, South Bethlehem, Penn., on State Control of Dams in Pennsylvania, will appear in abstract in a later issue of this journal.

THE FAILURE OF THE DAM AT AUSTIN, PENN.—In a volunteer paper, T. Chalkley Hatton submitted for record his first for-

mal statement of the facts regarding the construction and the failure of the Austin dam, and which, he believed, corrected some statements made by his professional brethren. He frankly stated that the two great mistakes he made were in not consulting an engineer more experienced than himself in dam foundations and in not insisting on a heavier cross-section. He stoutly maintained that, notwithstanding all assertion to the contrary, the concrete composing the dam was good, and he also stated that he had a competent supervising engineer on the ground during construction.

Certain Legal Aspects of Water-Power Development in Maine

A long paper on this subject was read by Cyrus C. Babb, Chief Engineer of the Maine Water Storage Commission. Legislation from 1641 on was reviewed in detail with court decisions bearing on the various statutes.

State supervision of dams in Maine was provided for in a limited degree in 1875 and to a much greater extent in 1909. Sec. 43 of the Mill Act of 1875 provided for the annual appointment, by the governor, of "a competent and practical engineer," whose duty it shall be, on petition from citizens, town or country authorities, to inspect any specified dam or reservoir, to hear witnesses summoned for the purpose and to report his findings to the governor. From 1883 to the present time the state has paid nine bills for such examinations, totaling the modest sum of $261.

Section 4 of an act of 1909, creating a State Water Storage Commission, provides for filing with the Commission plans for new dams and reservoirs, but the act provides no means for enforcing this provision, nor for a state examination to determine the sufficiency of the design, nor for inspection during construction.

The paper was concluded with a copy of a bill introduced in the 1911 legislature (not becoming a law) which provided for the creation of drainage districts, supervision of the construction of dams, and control and regulation of reservoirs.

Discussion of the papers by Messrs. Chandler, McKibben and Babb took place at all three of the sessions, and was participated in by several federal officials, among others. M. O. Leighton, chief of the hydrographic work of the U. S. Geological Survey, said that one of the chief objections which he had advocated to storage in some of his reports had been the menace to life and property that would result from the dams required to form the reservoirs. He favored state or federal control of the design of dams and the state licensing of engineers of all classes. He also advocated the adoption, in the Eastern states, of the legal doctrine of prior appropriation and beneficial use of water which prevails in far Western states. Riparian rights, which are the rule in the Eastern states, prevent the fullest possible beneficial use of a stream, and in many instances any use at all.

Morris Knowles, of Pittsburgh, said that all three papers are manifestations of the unrest of the times, and of the current desire for state control of various privileges. He referred to a recent proposal to consolidate the present Conservation Commission of California with several other commissions and give the enlarged commission broad powers of state control. He also mentioned the recent organization of the State Conservation Association of Pennsylvania, composed of various individuals and representatives of corporations.

Reasonable Water-works Fire-protection Requirements

A long paper, or a short monograph, on this subject was sent by Clarence Goldsmith, superintendent of the high-pressure system now being built for Boston, Mass. The whole subject was reviewed in detail. Pumps sufficient in number to supply the maximum demand when two of them were out of commission were advocated; also two discharge mains on direct pumping systems. A meter system was advised as the surest means of keeping water consumption and waste down to a draft which does not unduly increase fire risks.

Water for fire protection should be available, for concentration purposes, up to 1500 gal. per minute for outlying residential districts, 1000 to 5000 gal. in closely built-up and minor mercantile districts, and 5000 to 20,000 gal. in manufacturing, warehouse and residential districts. Gate valves should be sufficiently near together to make it unnecessary to cut out more than 500 to 800 ft. of street mains to repair a break. Fire hydrants should be so spaced as to make it possible to deliver all needed water to a fire from an average hydrant distance of not more than 350 ft. Hydrant spacing should be based on the block areas rather than lineal distances between hydrants.

A point in the paper worthy of special note was covered by the two following paragraphs, on portable outside hose gates for fire hydrants:

> From the operating standpoint the inside independently gated hose outlet cannot be considered as giving the best results. The leverage furnished by the wrench ordinarily used by the fireman is far in excess of that required to operate a valve of equal size in any other service, and so great that the stem can be broken or other parts crushed without any undue exertion on the part of the operator. The end to be attained may best be accomplished by attaching outside hose gates before the hydrant is open, and such a procedure will not introduce an objectionable delay. Such gates carried on hose wagons are more reliable, as they can be easily inspected and taken care of.
>
> The matter of original expense is also a very important item. Assume a city with 2000 hydrants and 16 hose or engine companies. To equip the 2½-in. outlets on all the hydrants would cost over $20,000, while to supply the 16 companies, each with four hose outlet valves, would cost about $650, and the cost of maintenance would be in about the same proportion. It is not so practicable to deal with the 4½-in. steamer outlets in the same way, because the portable valve is much heavier, so where it is desirable to connect a steamer to a hydrant which may already be delivering to a hose line, or where there are two steamer connections on a hydrant, it proves more convenient to equip these outlets with inside gates.

Finally, the author called attention to a fact too commonly overlooked or never grasped: namely, that adequate fire protection increases the cost of a waterworks system by from 50 to 100% over what would be required to provide water supply for domestic and business purposes only.

In discussing this paper, W. C. Hawley, of Wilkinsburg, Penn., called particular attention to the point last mentioned, and urged that the cost of fire protection, under public as well as under private ownership, should be met by a direct tax, so that the people would realize what they are getting in the way of adequate fire protection and what it costs.

"The Organization and Administration of a Supply Bureau" was the subject of a paper by E. C. Church, head of the supply bureau of the Department of Water Supply, Gas and Electricity, New York City.*

Supplies for all five boroughs are bought by this bureau which is organized into divisions of purchase, inspection and stores. Storehouses have been provided for each borough. Supplies have been standardized and all possible publicity is given to contract lettings. Recently 800 personal letters were sent out calling attention to the prospective opening of bids for miscellaneous supplies. As a result, 55% more bids were received than at any previous letting.

The last paper on the program was, "State Regulation of Public Utilities," by Morris Knowles, of Pittsburgh. This will be abstracted in another issue. F. Herbert Snow, Chief Engineer, Pennsylvania Department of Health, Harrisburg, in the discussion, stated that privately owned water plants in Pennsylvania are better than publicly owned works, the former being under state control. When cities buy out the companies this state control ceases, although it ought to be continued.

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*A paper by Mr. Church before the recent meeting of the American Water Works Association dealt with "the Philosophy of Purchasing Supplies," and was printed in our issue of June 13, 1912.

Annual Meeting of the American Public Health Association

The fortieth annual meeting of the American Public Health Association, held at Washington, D. C., Sept. 18 to 20, showed that much needed new life has recently been infused into the organization. Added stimulus was given to the attendance and to the proceedings this year by the fact that the meeting immediately preceded the International Congress of Hygiene and Demography, also held in Washington. Between these two great gatherings come the Annual Conference of State and Provincial Boards of Health. Coincident with the Public Health meeting was the annual convention of the New England Water Works Association.

A wide range of subjects was included in the 133 papers on the program of the American Public Health Association. These papers were presented, in part, before the whole Association in General Sessions, during which the various sessions had no meetings, and in part they were distributed between the five sections: Laboratory, Vital Statistics, Municipal Health Officers, Sanitary Engineering and Sociological. The Sanitary Engineering Section appeared on the program for the first time, having been organized a year ago. It had a long list of papers, including symposia on sanitary engineers in relation to public-health work, refuse disposal and water pollution. The section now has about a hundred members, including those elected at Washington.

The following notes on the meeting relate principally to the proceedings of the Sanitary Engineering Section, but have been grouped by main topics, regardless of sectional or chronological order.

Water Pollution and Various Phases of Sewage Disposal

A single paper on stream pollution was read before the first of the General Sessions and 13 papers dealing with various phases of stream pollution, were on the program of the Sanitary Engineering Section. Several papers on sewage disposal were also read before the Sanitary Section and one before the General Session.

Pennsylvania—The paper on stream pollution before the General Session told "What State Control Over Streams has done in Pennsylvania in Seven Years" and was presented by Dr. Samuel G. Dixon, Commissioner, Department of Health of Pennsylvania. Acting under legislative powers granted in 1905, anti-pollution policies have been worked out to suit the different drainage areas of the state, and many municipal and private corporations and individuals have been compelled to adopt complete plans for sewerage and sewage disposal, to be carried out from time to time, as needed, until completed. A total of 628 sewerage and sewage-disposal permits and decrees have been issued; 419,000 premises have been inspected and over 30,000 cases of water pollution have been abated. Up to July 1, 1912, sewage-treatment plants to the number of 52 had been installed in Pennsylvania, including municipal, institutional and private plants.

The policy of the department is to require that all sewage be treated ultimately, the exact time to depend upon the conditions pertaining to each case. On upland streams, used for water-supplies, a high degree of purification is required. On small streams, complete nitrification of all organic matter is demanded. This costs from $30,000 to $60,000 per 1,000,000 gal. of work capacity. In response to questions, Doctor Dixon stated that purification is (or will be) required even where the effluent is not discharged into streams used for public water-supplies, because cows wade in such streams, and by them infection may be carried to towns.

Great attention is also being given to water purification in Pennsylvania. Of 81 water-purification plants now in use, 66 are mechanical filters, 11 slow sand and 4 provide less effective treatment. The water-supply of over 3,000,000 people is now purified: 51% by slow sand filters, 46% by mechanical filters and 4% by other means.

Since the organization of the present department of health there has been a 60% reduction in typhoid fever for the whole of Pennsylvania. Some [much?—Ed.] of this has been due to causes not connected with the campaign against polluted water-supplies carried on by the State Department of Health.

The Water-Pollution Problem—The symposium on water pollution, already mentioned, was briefly introduced by Paul Hansen, of Urbana, Ill. Mr. Hansen remarked that heretofore engineers had formulated conclusions regarding water pollution only in connection with individual cases, probably because of the fact that each stream is largely a law unto itself. He thought it now proper to agree on general principles.

F. L. Olmsted, of Brookline, Mass., sent a paper dealing with "Storm-Water Discharge and Park Functions," in which he discussed various phases of preserving and enhancing the natural attractions of streams which flow through or by towns. The land adjacent to such streams is often of far more value for public than for private uses.

Prof. Earle B. Phelps, of New York and Boston, submitted an illuminating paper on "The Chemical Measure of Stream Pollution and Specifications for Sewage Effluents." The basis of measurements should be governed by the character of the nuisance or danger to be averted. If bacteria are the object of attack, then since pathogenic germs do not multiply in polluted water, samples for quantitative determinations should be chosen so as to reflect the maximum reduction in total bacteria.

The German determinations of settleable matter removed have much to commend them when the efficiency of settling tanks is to be judged.

It is not the quantity of organic matter but its demand for oxygen which gages its effect on a stream. Nor does the degree of purification effected signify without knowing the volume of effluent to be discharged. Look first to the stream rather than to the effluent when fixing a standard. Ascertain its available oxygen and its capacity for the recreation of oxygen. Then determine the total volume of oxygen required by the sewage of all the towns tributary to a given stream and apportion the available oxygen accordingly. The rights of each community should be established by the state.

Prof. H. N. Parker, of Urbana, Ill., sent a paper on "Pathological Dangers to Domestic Animals from Contaminated Streams." His conclusions were that the subject had not been thoroughly investigated and might well be taken up by state experiment stations. The indications are that anthrax, parasitism and metallic poisoning are spread among animals by stream polution and that cows spread typhoid among men by wading in sewage-polluted water.

"The Sludge Problem" was discussed in a paper sent by Langdon Pearse, of the Sanitary District of Chicago. Sludge deposits at a given point may be prevented by dredging, which is temporary; by by-passing, which is not always feasible; and by the removal of suspended matter. Screening will remove the coarser and sedimentation practically all of the suspended matter from sewage.

Charles Saville, of New York City, sent a paper on "Practical and Just Legislation Governing Stream Contamination." Classification of streams by uses was suggested. Laws prescribing the exact degree of cleanness to be maintained are not desirable. Boards of stream control were advised. These may or may not have the power to construct works. Reference was made to the Emscher District in Germany, which has regulated many miles of stream channel and built more than 30 disposal works.

"A Study of the Waters of Lake Michigan," by Dr. M. P. Rovenel and E. J. Tuely, of Madison, Wis., has led them to conclude that the water of that lake is nearly always polluted, even to a distance of seven miles from shore, and sometimes badly polluted. To insure safety, water would have to be taken from 10 to 12 miles out, which would be impracticable.

Treatment with hypochlorites is necessary. The lakes should not be used as cesspools.

A volunteer paper entitled "Permissible Limits of Sewage Pollution," but dealing specifically with the waters surrounding New York City, was sent by George A. Soper, of New York City. It summarized answers made by eight experts to a series of questions regarding the pollution of New York Harbor. The questions were drawn by the Metropolitan Sewerage Commission of New York, of which Mr. Soper is president. The eight experts represented the professions of engineering, chemistry, biology and sanitary science; one or more were foreigners. Their names were not reported. All believed that something should be done to prevent the pollution of New York Harbor, but there was considerable difference of opinion as to the standards which should be established. The conclusions drawn by the Commission itself as to the degree of cleanliness that should be maintained in New York Harbor may be summarized as follows:

(1) No visible solid matter of sewage origin.

(2) No marked discoloration, turbidity or oily sleek, and no odor or deposits, except, perhaps, immediately at outfalls.

(3) No deposits materially injurious to navigation.

(4) Except close to sewer outfalls, dissolved oxygen not to fall below 3 c.c. per liter of water, or about 60%. Enough oxygen near outfalls to prevent nuisance from odors.

(5) The necessary safe standard for protection to bathers and to consumers of shellfish (i.e., bacterial drinking-water standard) is impracticable north of the Narrows and in Arthur Kill and elsewhere within a mile of a sewer outfall.

SEWAGE TREATMENT VS. SEWAGE PURIFICATION—George C. Whipple, of New York City, read a paper with this title before the General Session. The burden of the paper, and a weighty one, was that for the most part "sewage purification" does not purify; that the public is misled by the term into a feeling of security which is false; that as a rule it is necessary to do no more than treat sewage to a greater or less degree, depending upon local conditions; and, most important of all, sewage treatment is rarely a material protection to public health, and that when the public health is involved water purification rather than sewage purification should be the chief reliance.

DISCUSSION—(The discussion here reported was before the Sanitary Engineering Section). F. H. Snow, of Harrisburg, Penn., disagreed with Mr. Whipple's assertion that there is little relation between sewage purification and health. There have been many instances in Pennsylvania where a breakdown of water-purification works has caused many deaths. A double barrier should be provided.

J. L. Ludlow thought that stress enough had not been laid upon the difference between streams used and those not used for public water-supplies, and that streams must serve for waste disposal and for pressure as well as for water-supply. Moreover, if North Carolina towns and villages were called upon to treat their sewage, as well as provide sewerage systems, neither would be done and sewage wastes would not be removed from the homes of the people. Dr. John A. Amyott, of Toronto, Ont. (representing the medical viewpoint), said that sewage treatment is not prohibitive in cost; it is sewers that are costly. A small town can purify its sewage for a few thousand dollars.

H. P. Eddy, of Boston, Mass., said that engineers must make a dollar go the farthest possible way in conserving human life. He doubted whether dollars count most when used for sewage purification. He would hesitate to mention a single sewage-purification plant that really purifies. He could not agree with Doctor Amyott that sewage-purification works are not costly.

T. Chalkley Hatton, of Wilmington, Del., told how the city named got a dose of typhoid fever as a result of an outbreak at Coatesville, Penn., some months ago, notwithstanding the filtration of the Wilmington water-supply and notification by the Pennsylvania authorities of the Coatesville epidemic. The Wilmington filters were temporarily deranged at the time and when hypochlorite was used some error was made, at first, in its introduction. The hypochlorite was finally effective.

Professor Phelps, while agreeing that money counts for more when spent in water purification, because the barrier is nearer to the consumer, was inclined to agree with Mr. Snow that two barriers are needed. Lawrence, Mass., had a typhoid outbreak one winter when its water filter broke down. Mr. Whipple here explained that he believed reliance should be placed on water purification first and on sewage purification next. We need to learn what degree of pollution renders a water unsafe to apply to a water filter. Money goes further in water than in sewage purification. Rudolph Hering, of New York City, indorsed Mr. Whipple's stand. An engineer cannot get away from costs.

SKILLED SUPERVISION OF SEWAGE-DISPOSAL WORKS—At a subsequent session of the Sanitary Engineering Section, F. H. Snow read a paper on this subject, which we expect to abstract in a later issue. He again spoke of the necessity of two barriers between typhoid-infected discharges into water and the water consumer, urged that the art of water purification is not keeping pace with increasing water pollution in some parts of the country and that we have few experts competent to pass on the real dangers from polluted water. Local, state and national supervision of sewage-purification plants are all necessary.

In discussing this paper, Paul Hansen, of Urbana, Ill., stated that when, in 1907, the Ohio State Board of Health began the study of the 35 sewage-treatment plants in that state, it found not one of them properly operated. During the inspection period the operation improved, but subsequently it fell off until it is now likely that it has gone back. Recent inspection of a half dozen Illinois plants found not one properly operated. All this emphasizes the need of state supervision, which is equally needed for water-purification plants. Skilled local supervision is also necessary. The employment of consulting supervising engineers for periodic inspection was suggested.

The discussion on Mr. Snow's paper, and on sewage vs. water purification closed with some significant remarks by Mr. Eddy, who first said that a most vital point had not yet been mentioned. The water-works operator is directly responsible to the sufferers from poor management of a water-purification plant. This is not true of a sewage-purification plant, the poor operation of which affects the people of some other community. For many years to come it will be impracticable to hold sewage-purification works to the same efficiency as water-purification works. It therefore becomes necessary to depend upon the police power of the state, but the courts afford a slow and unsatisfactory protection. Sewage purification is intricate. The system chosen should be as nearly fool proof as possible. Nearest to this comes the old process of sand filtration.

THE CONTROL OF TYPHOID IN CITY AND COUNTRY

A series of papers on the prevention of typhoid fever was opened by Dr. L. L. Lumsden, of Washington, D. C. With all our reduction in typhoid of late the United States still has a death rate from this disease from two to seven times as great as that of various European countries. We ought to go in sackcloth and ashes until our typhoid rate is reduced to at least five per 100,000 population. The rate in some foreign cities is down to two and even one. What can be done elsewhere can be done here since the disease is spread by the same bacillus in every part of the world. The two great means to this desired end are sewerage systems for cities and towns and sanitary privies for the country. The people must be convinced that the investment will pay.

In the course of a paper on "Rural Typhoid in Manitoba," Dr. R. M. Simpson, of Winnipeg, suggested that the

cities and towns may have to go out and build concrete privy vaults in the surrounding rural districts.

The marked reduction of very high typhoid fever in North Yakima, Wash., and the surrounding country during the past two years was described by Dr. Thomas Telrau, of North Yakima. The sewage of the town was discharged into the river three miles above the intake of two large irrigation canals used to water a closely settled agricultural community. It appears that many open privies in the town contributed, through flies, to a heavy typhoid rate and that the sewage of the town carried the typhoid to the country, from which it came back via milk, cream, and butter. A full-time health officer for the town and country, a number of sanitary inspectors and a visiting nurse, the introduction of sanitary privies and other sanitary advances have been followed by no typhoid deaths in the town during a period of fifteen months, while those in the country outside were reduced from 64 to 8 per year.

Dr. Wm. C. Hanson, of Boston, made a plea for a more widespread interest in the control of typhoid and told of organized efforts for the reduction of typhoid in Massachusetts now being made by the State Board of Health and its staff of district medical inspectors. Studies of records are being extended over large districts and considerable periods of time. Dr. Chas. F. Bolduan, of New York City, stated that typhoid in the cities of the United States cannot be brought down to foreign levels without reforms in public-health administration, especially in rural districts. Probably 25% of the typhoid of New York City is due to out-of-town infection. Rural health administration should be organized in larger units, with trained full-time men in charge, and with state supervision. Salaries of $3000 a year should be paid these men at the beginning, besides expenses. The state might have to pay half of the rural salary bill.

Garbage and Refuse Collection and Disposal

Before the Municipal Health Officers' Section Dr. P. M. Hall, of Minneapolis, and Dr. Terry, of Jacksonville, Fla., treated garbage disposal as an important public-health matter. Dr. Hall went as far as to say that it is still a debatable question whether decaying vegetable matter does not afford a breeding place for pathogenic germs. Dr. Terry believed that boards of health should collect and dispose of garbage. Where this is the rule incinerating plants are generally found. M. N. Baker, of Montclair, N. J., believed garbage collection and disposal have little relation to the public health and can be handled more efficiently and economically by the public works than by the health department. Dr. E. C. Levy, of Richmond, Va., had changed his mind and now believes that there is a very intimate connection between refuse disposal and filth, particularly night soil.

Ten "five-minute papers" on city refuse collection and disposal were on the program of the Sanitary Engineering Section. Rudolph Hering led off with remarks on the need for more accurate refuse data, including quantitative and qualitative analyses and cost figures. S. A. Greeley, of Winnetka, Ill., dealt with the need for accepted definitions of the various classes of refuse and for standard forms of refuse statistics. John H. Gregory, of New York, sent a paper on refuse collection, in which he mentioned a 9-cu.ft. wagon, with movable partition, now being tried in New York for the joint but separated collection of garbage and ashes.

Geo. S. Smith, of New Orleans, described a system of refuse disposal by dumping on and filling in low marshy ground. The refuse is shipped by rail at night from five city stations, unloaded from the railway cars to smaller cars which run on portable tracks. A. M. Compton, of Davenport, Iowa, told of burying garbage on the bank of the Mississippi, after the federal government had forbidden dumping in the river. The garbage is dumped over the edge of the sloping bank and immediately covered with six to ten inches of dirt. In 1911 the use of a mattress of chicken wire to prevent the washing away of the refuse by high water was begun. Latterly, a retaining wall has been built and land is being reclaimed within 600 ft. of the business district of the city.

"Garbage Piggeries" at Grand Rapids, Mich., were described by A. W. Brown, manager of the pig farm near that city. A contractor takes garbage by railway cars from the city to a hundred-acre farm, some 20 acres of which are used to care for 6000 hogs. From this establishment foundation stock has been supplied for a number of other garbage piggeries. The pigs are immunized against hog cholera when young.

I. S. Osborne, of Cleveland, Ohio, and J. T. Featherstone, of West New Brighton, New York City, dealt with reduction and incineration respectively. Finally, W. F. Morse, of New York City, told an interesting story of the work done by a Boston benevolent society devoted to small animals. Such of these as have to be made way with are electrocuted for a fraction of a cent each, then burned in a small furnace which makes use of gas for fuel.

Street Cleaning in Relation to Health

In the course of a paper on this general subject, Samuel Whinery, of New York City, said that, broadly speaking, it is not until street dirt becomes street dust that it is a menace to health. From this viewpoint, efforts should be concentrated on dust prevention. The ideal method to effect this end is the patrol system combined with the rubber squeegee or with flushing.

The Relation of the Sanitary Engineer to Public Health Service

Two papers on this topic were read before the Sanitary Engineering Section, and were submitted to "three-minute" discussion by a dozen named persons and a number of volunteers. C. H. Wells, of Montclair, N. J., submitted "A Plea for a More General Recognition of the Qualifications of the Sanitary Engineer for Administrative Public-Health Work." Rapid changes in the conception of public-health work have demanded of the health officer an increasing range of knowledge and activity in sanitary engineering lines, and more and more executive ability. The training of the sanitary engineer goes farther than does that of the physician in fitting him for the administration of public-health work, and as no one man can be qualified in all branches of this work, but must rely at some points upon the services of experts in other lines. The sanitary engineer, if he has executive ability, is in many respects the ideal man for a health officer. This is not urged to displace the medical man, but solely to give the sanitary engineer a fair chance in a field for which he is qualified but from which custom and misconceptions have generally excluded him.

In a paper named "Public Health Service not a Medical Monopoly," Morris Knowles, of Pittsburgh, Penn., showed that while a number of states, beginning with Massachusetts, had placed no restrictions on the professional qualifications of members of state boards of health, yet most of the states of the Union require that at least a majority shall be physicians. Progress in the knowledge and practice of public-health matters have relegated the physician to a relatively minor place in this field; or at least have placed by his side the engineer, the chemist, the bacteriologist, the demographer, and the sociologist. The universities of this and foreign lands now offer courses of training far better designed than are the medical courses to fit men to be public-health officers, but the statute books of most of our states still exclude from health work these men trained in the better schools and insist on the choice of the men of less adequate training.

The Massachusetts Sanitary Commission sixty years ago, recommended the creation of a state board of health composed of two physicians, one lawyer, one chemist, one natural philosopher, one civil engineer and two persons otherwise qualified. The report of this commission showed a wonderfully broad conception of the nature of public-health work and of the kind of men needed to direct it. The same may be said of British writings on the subject dating sixty years back.

Among all the states, Alabama has the most ill-suited method of choosing the personnel of its health administrators. Ever since 1871 its state board of health has been composed of the entire membership of the State Medical Association, which now numbers 1800. The same general plan is followed in some of the other Southern states.

In the discussion of this paper, Dr. W. S. Rankin said that the best health officer is the man who reduces or holds down the death rates, regardless of where he graduates. H. P. Eddy, of Worcester, states that one of the best health officers he knew was, many years before, a machinist, and a good machinist. M. N. Baker said that his eighteen years' experience with an engineer as health officer of Montclair, N. J., had been eminently satisfactory.

Other Topics and Papers

It is, of course, impracticable even to name all the topics and 130 papers on the program. Vital statistics were considered from all angles. There were a few sociological papers, one or more on industrial hygiene, many on laboratory work, and a large number on general health subjects.

In the course of an interesting paper on "The Value of Human Life," Dr. Charles V. Chapin, of Providence, R. I., the speaker, asked if there is not a general feeling among taxpayers that the loss of a human life now and then is not a very serious matter when it is so easy to find a new worker? The subject ought not to rest wholly on an economic basis.

A paper on "The Need of Health-Protective Surveys and Programs" was read before one of the General Sessions by M. N. Baker. Surveys are needed in order to map out a program which will cover the whole field, instead of overlapping or leaving bare spots, and which will insure right proportions for the different classes of work, a proper sequence of time and such a distribution of funds as will result in the greatest returns for every dollar spent. It is particularly desirable that the national, state and local fields of health-protective work be delimited. A closely related paper by the same author, before the Health Officers' Section, dealt with the need for a systematic functional classification of health-board expenditures. A classification into direct and indirect health-protective work was suggested, with the whole range of municipal cleansing expenditures classified as indirect.

Prof. F. H. Bass, of Minneapolis, Minn., described some promising experiments on school-room ventilation, made in one of the city schools with an appropriation granted by the University of Minnesota. Working on the assumption that ventilation is a matter of physiology rather than of pathology, and that it is not necessary to supply one hundred times as much air as is breathed per capita, a system was devised which delivered washed and humidified air to each pupil at the desk-top level and removed the foul air from openings in the ceiling. The air was delivered at the rate of 8 cu.ft. per min. per pupil, through an opening in the tops of the desks. The results appeared to be good. With hollow-legged desks to serve as air uptakes, the installation cost of this system of ventilation would probably not be more than that of the ordinary system. The measured velocity of the air at the face of the pupils was about 1½ ft. per sec. [5400 ft. per hr. for comparison with wind velocities].

Stephen De M. Gage, of Lawrence, Mass., read a paper on artificial humidification of the air of textile mills. The process reduces the bacterial content of the mill air, provided that polluted water is not used.

Business Matters

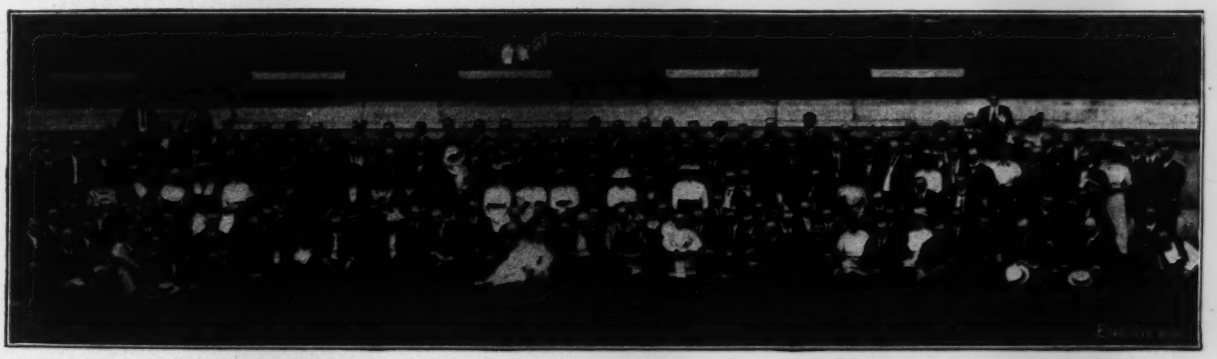
The engineers connected with the Association were particularly pleased by the election of Rudolph Hering as president of the Association for the ensuing year. Prof. Selskar M. Gunn, of the Massachusetts Institute of Technology, Boston, Mass., was reëlected as secretary.

For chairman of the Sanitary Engineering Section, J. L. Ludlow, of Winston-Salem, N. C., was elected to succeed Mr. Hering. Herbert D. Pease, of New York City, was reëlected as secretary and Prof. Geo. C. Whipple, of New York and Cambridge, Mass., was reëlected as recorder. Six technical committees were created in this section, corresponding with the six objects which the section was established to promote. The committees and their chairmen are as follows: Air, Prof. W. T. Sedgwick, Boston; Water, Geo. W. Fuller, New York; Sewage Collection and Disposal, Geo. S. Webster, Philadelphia; Refuse Collection and Disposal, S. A. Greeley, Winnetka, Ill.; River Cleaning, Geo. C. Whipple, New York and Cambridge; Street Cleaning, Samuel Whinery, New York City.

Colorado Springs, Colo., was decided on as the meeting place in 1913.

The International Association for Testing Materials in Washington

The accompanying cut is reproduced from a photograph taken of the members of the International Congress for Testing Materials assembled at the U. S. Bureau of Standards in Washington. The members of the Congress spent two days in Washington. A reception and garden party were given at the White House in their honor, at which Secretary Nagel, of the Department of Commerce and Labor, received the delegates in the absence of President Taft.



Members of the International Congress for Testing Materials at the U. S. Bureau of Standards, Sept. 10
(Photo by Washington Photo Co.)

Grade reduction on the Western Pacific Ry. includes the construction of a 10-mile cutoff to eliminate about 4½ miles of 3% grade against westbound traffic. This will in effect form a double-track line, since the present line with the heavy grade will continue to be used for eastbound traffic, while the new line (with maximum grade of 1%) will be for westbound traffic. This cutoff is known as Arnold's loop, and is at Silver Zone Pass, about 145 miles west of Salt Lake City. The work is under the direction of T. J. Wyche, Chief Engineer, and is estimated to cost $570,000.

Notes from Engineering Schools

RICE INSTITUTE—The first academic year of this institution for collegiate instruction in arts and sciences opened Sept. 23. The formal celebration of the event will occur at Galveston, Tex., Oct. 10, 11 and 12. The program includes various entertainments and a series of lectures by a number of well known scholars from abroad.

This institution was founded by funds of the late W. M. Rice, $10,000,000 being made available. The sum has been equally divided into equipment and endowment funds. Edgar D. Lovett, professor of mathematics in Princeton University, was chosen president in 1908. A tract of 300 acres was secured about three miles from the center of Houston and Cram, Goodhue & Ferguson, of Boston, were selected as architects. An administration building, mechanical laboratory, power house and residential hall for men have been erected. Other buildings are being designed.

COLUMBIA UNIVERSITY — The Department of Extension Teaching will offer the following three courses in civil engineering subjects during the coming academic year:

(1) Plane surveying; Wednesday evenings, 7:30 to 9:10; covering the principles, use and adjustments of the compass, transit and level, and computations, methods, etc., for land, topographic and construction surveys.

(2) Railroad surveying; Monday evenings at the same hour; including lecture and problem work in simple, compound and transition curves, frogs and switches and earthwork and estimates.

(3) Practical course in reinforced concrete; Thursday evenings; taking up the proper proportioning of concrete, the theory of reinforced concrete, and numerous problems and designs.

The above courses consist of 32 weekly periods and will open Sept. 26, continuing until May 22. Particulars may be secured from the Secretary of Columbia University, New York City.

UNIVERSITY OF PENNSYLVANIA—What has been known as the "College" has been divided into three distinct schools. There is now, first, the "College," which will be a department of arts and sciences, administering also the summer-school and teachers' courses. Secondly, there is the Towne Scientific School, giving the courses in architecture, chemistry, and in chemical, civil, electrical, and mechanical engineering. The third division is the Wharton School of Finance and Commerce. This school has existed in the past, but only as a department.

The administration of the old "College" has been vested for years in one dean and an academic council, consisting of heads of departments and full professors. By the change, three faculties have been created containing men of professorial rank who have had in the past no seat in the academic council, who have not been members of committees and have had little to do beyond classroom work. Arthur H. Quinn has been made dean of the "College," John Frazer dean of the Towne School, and Roswell C. McCrea dean of the Wharton School.

The Grounding of the Battleships "Louisiana" and "Nebraska" recently, off the Rhode Island coast, has resulted in the detailing of two parties to make resurveys of the dangerous sections of the coast. According to a press dispatch from Newport, one party is now working along the west passage of Narragansett Bay, where the "Louisiana" struck an uncharted shoal, and the other party is working off Block Island, where an uncharted rock was struck by the "Nebraska" during the summer maneuvers.

An Exhibition of Mine Rescue Work was given by rescue teams from mines all over the country, at the National Mine Rescue and First-Aid Conference, held at the Bureau of Mines experiment station in Pittsburgh, Penn., on Sept. 23-26. The conference of last year is thought to have been partly responsible for a decrease in the number of deaths from accidents in 1911, and it is hoped that these demonstrations of practical and approved rescue methods will be of still further aid. (A more detailed account of this conference is given under "Engineering Societies.")

Repair of the Irondequoit Break in the New York State Barge Canal is being done in a temporary way, to reëstablish canal navigation (for the small boats of the old Erie Canal) as rapidly as possible. The concrete trough of the new canal section has been closed off at each side of the break by a concrete dam, with an opening along the south side wide enough to take a wooden flume just capable of passing Erie Canal boats. This flume, built for 7-ft. depth of water, rests on low concrete footing walls at either end, on the floor of the trough, and is to be carried over the break on a pile trestle. The pile and flume work is now going on.

Five Additional Subway Contracts for construction work on the New York City dual system, and aggregating $8,292,721, were awarded during the week past. Two of the sections were on the Broadway subway in lower Manhattan, and went to F. L. Cranford, 177 Montague St., Brooklyn, at $1,222,269 and $982,741, respectively. Two sections of the Brooklyn Fourth Ave. extension were secured by the Degnon Contracting Co., 60 Wall St., New York, at $1,930,259 and $1,904,171, respectively. The fifth section, on the Bronx Southern Boulevard line, went to the J. F. Stevens Construction Co., 55 Wall St., New York, at $2,253,282.

Two South Side Tunnels in Pittsburgh, Penn., have been decided on by the County Commissioners of Allegheny County, and a corresponding petition has been presented by the Commissioners to the county court, for approval of the project by the Grand Jury. The first tunnel, 5500 ft. long, is planned to extend from First St. and East Carson St. southwesterly to a point on Warington Ave. near the Pittsburgh Railways Co.'s car barn. The second tunnel, 4850 ft. long, is to extend from Carson St. at a point 1200 ft. east of the Monongahela River Point Bridge, southeasterly to Woodville and Banksville Ave. Each tunnel is estimated to cost about a million dollars.

The Sheridan Road Drive, the principal road and automobile route from Chicago, along the north shore of Lake Michigan, is in very bad condition in places owing to the lack of care and maintenance by the several villages and towns through which it passes. Efforts are being made to have the drive turned over to the care of the Lincoln Park Commission, to which the city of Chicago has already graned that section within the city limits. The Commission is willing to assume control from that point to the state boundary. The law permits ths step to be taken, but the road must be taken over continuously, which necessitates concerted action by the various local authorities. At Evanston, the route is lost for several blocks, but property owners are willing to grant sufficient land if the reconstruction can be undertaken by the Commission. Temporary repairs have been made on the 8-mile stretch between Highland Park and Glencoe, at the expense of the Sheridan Road Improvement Association, the work being done under the direction of the Park Commission by special arrangement. The cost of this work was about $16,000.

The Chicago Municipal Subway System planned by the Subway Commission and the subway committee of the council committee on local transportation provides for 56 miles of line at an estimated cost of about $131,000,000. There are (1) two general routes from the north and northwest districts to the south and southwest; (2) a direct route on Madison St. between the business district and the west side, and (3) a direct north and south line on Halsted St. The limits of the system are Laurence Ave. on the north, 79th St. on the south, and 40th Ave. on the west. The estimated cost includes $96,257,000 for construction and $34,844,000 for equipment. The report states that, after the routes are approved by the City Council, plans and specifications shall be prepared and bids invited under three propositions: 1. construction of the subway system; 2. construction and operation; 3. operation only. The third-rail system of conductors is proposed, and the cars are to be of steel construction with seats for 60 passengers. For purposes of ventilation each track is to be in a separate compartment or subway except at stations, depending upon the piston action of the cars for changing the air. The subways will be as near the street surface as possible, dropping to a deeper level only at intersecting points. Most of them will be double track but on State St. (from North Ave. to 55th St.) there will be four tracks side by side. The report recommending this subway system has now to be submitted to the City Council.

A Sale of 800,000,000 ft. b.m. of Standing timber has been made by the Bureau of Forestry of the U. S. Dept. of Agriculture to a California lumber company. The timber is located in the Sierra National Forest and the contract has been awarded after public advertisements and the receipt of sealed bids. In cutting the ripe timber on the tract included, the company will be allowed to cut only about two-thirds of the standing trees, leaving sufficient young growth to provide for reproduction of the timber growth in future years.

The company will have to build about 70 miles of standard-gage railway to open up the area in which the timber lies and is given a period of 22 years in which to cut the timber, with two years additional for the construction of logging and manufacturing facilities. In view of the long term of years involved in the sale, a readjustment of the stumpage prices is provided every five years, based on the prices during the two years preceding of manufactured lumber in the markets where the timber is sold. The National forest reserves now contain, it is estimated, nearly 600,000,000,000 ft. of timber of merchantable size, not including the young growing trees which should be preserved for future use. Most of this standing ripe timber, however, is so remote from market and so difficult of access that it cannot be sold on any terms, as the cost of cutting and hauling it would exceed its market value. In order to sell it at all it is necessary to sell it in large blocks, as has been done in the present case, so that the purchaser is warranted in making the heavy investment necessary to make the timber accessible and remove it. While the forest service has been selling about $1,000,000 worth of stumpage in the national forest reserves per annum, it has generally been sold in comparatively small amounts. The total amount of such cutting, together with what is cut for free use, is only about an eighth of what might be cut in the National forests without reducing their permanent value as timber reserves. The present sale of a large body of timber to be cut through a long series of years marks a new departure in the policy of the Forest Service, and promises to add to the market supply a vast amount of timber from the National forests which is now going to decay.

Personals

Mr. X. H. Cornell has resigned as Superintendent of Transportation of the Chicago & Alton R.R., at Chicago, Ill., and the office has been abolished.

Mr. Marshall P. Robertson, M. Am. Soc. C. E., has been appointed Assistant State Engineer of Louisiana, succeeding Mr. Hugh C. Smith, whose term has expired.

Prof. H. W. Miller, of the department of general engineering drawing, University of Illinois, has been appointed Assistant Dean of the college of engineering.

Mr. J. F. Putnam, recently Instructor in civil engineering at Cornell University, has been appointed Professor of physics at St. John's University, Shanghai, China.

Mr. F. C. Loring, formerly with the Metropolitan Street Ry. Co., New York City, has been appointed Instructor in electrical engineering at the University of Illinois, Urbana, Ill.

Mr. H. S. Eames, recently Instructor in mechanical engineering at the Rhode Island State College, has been appointed Instructor in mechanical engineering at the University of Illinois, Urbana, Ill.

Mr. B. Mitchell, Jr., recently Associate Professor of mechanical engineering at the University of Arkansas, has been appointed Instructor in machine design at the University of Illinois, Urbana, Ill.

Mr. A. Swartz, whose resignation as Division Engineer of the Erie R.R. was noted in our issue of Aug. 1, has been appointed Engineer of Maintenance-of-Way of the Toledo Electric Ry. & Light Co., Toledo, Ohio.

Prof. A. B. McDaniel, M. Am. Soc. C. E., formerly head of the department of civil engineering at the University of South Dakota, has been appointed Assistant Professor of civil engineering at the University of Illinois, Urbana, Ill.

Mr. J. T. McGrath, Superintendent of Motive Power of the Chicago & Alton R.R. has resigned, effective Oct. 1. It is reported that he will be succeeded by Mr. J. E. O'Hearne, Master Mechanic of the Wheeling & Lake Erie R.R., at Brewster, Ohio.

Mr. G. I. Evans, Mechanical Engineer of the Canadian Pacific Ry., Montreal, Que., has been appointed Superintendent of the locomotive shops at Angus, Montreal. Mr. Evans began engineering work as a draftsman with the Canadian Pacific Ry. in 1900.

Mr. D. Burkhalter, formerly Superintendent of the wood preserving plant of the Buffalo, Rochester & Pittsburgh Ry., at Bradford, Penn., has accepted a similar position with the Eagle Harbor plant of the Pacific Creosoting Co., with office at Seattle, Wash.

Mr. A. F. Comstock, Assoc. M. Am. Soc. C. E., formerly Associate Editor of "Engineering Record" and more recently Civil Engineer with the Lackawanna Steel Co., of Lackawanna, N. Y., has been appointed Instructor in railway civil engineering at the University of Illinois, Urbana, Ill.

Mr. S. S. Wagar, former Chemist of the St. Louis & San Francisco R.R., has been appointed Chemist and Engineer of Tests of the Buffalo, Rochester & Pittsburgh R.R., with headquarters at Du Bois, Penn. Mr. Wagar was educated at the Rensselaer Polytechnic Institute and began engineering work in 1910 as a material inspector with the Union Pacific R.R. For a short time he was Assistant Chemist of the Missouri Pacific Ry.

Mr. L. L. Jewell, M. Am. Soc. C. E., has resigned as Manager of Erection for the McClintic-Marshall Construction Co., contractors for the steel work of Panama Canal, and is now President and Chief Engineer of the Central American Construction Co., a corporation recently organized under the laws of the Republic of Panama to carry on a general contracting business. Mr. Jewell has been in charge of the erection of the canal lock gates since the beginning of the work in May, 1911. Mr. Jewell is succeeded by Mr. W. M. Sterrett, who has been Manager of the McClintic-Marshall Construction Co.'s plant at Pottstown, Penn.

Mr. Howell H. Althouse, Assistant Engineer of the Erie R.R., has been promoted to be Chief Engineer with office at New York City. Mr. Althouse was born at Pottsville, Penn., in 1869, and received his education in public high schools. At 20 years of age he began engineering work as a rodman with the Lehigh Valley R.R., and was soon promoted to the position of levelman. For the two years, 1890 to 1892, he was a transitman for this railway and then, for two years, was engaged on the construction of the sewage disposal plant at Pottsville, Penn. In 1894 he returned to railway work as a transitman with the Philadelphia & Reading Ry., and later held a similar position on construction work for the Central R.R. of New Jersey. In 1899, he accepted a position with the Erie R.R., and for two years he was Assistant Engineer on surveys and construction work at Galion, Ohio. Since 1902 he has been Assistant Engineer at New York, and since July, 1912, Principal Assistant Engineer of the Western lines.

Mr. H. J. Slifer, M. Am. Soc. C. E., General Manager of the Chicago Great Western R.R., Chicago, Ill., has resigned, and the office has been abolished, the duties now being assumed by the Vice-President. Mr. Slifer was formerly Business Manager of the construction department of J. G. White & Co., New York City. He is a native of Pennsylvania and a graduate of the Polytechnic College of Pennsylvania. His engineering career began in 1880 as a rodman with the Mexican National Construction Co., where he soon became a transitman. From 1882 to 1891 he was Assistant Engineer with the Pennsylvania R.R., and for a short time following Principal Assistant Engineer of the Milwaukee, Lake Shore & Western Ry. Mr. Slifer was Division Engineer of the Chicago & Northwestern Ry. from 1893 to 1897, when he changed to the operating department as Superintendent of the Iowa division. From 1902 to 1905 he was General Superintendent, first of the Eastern district, and later of the Central district of the Chicago, Rock Island & Pacific Ry. From 1905 until a few years ago he was with J. G. White & Co., as already mentioned.

Mr. W. J. Harahan, M. Am. Soc. C. E., Vice-President and Chief Engineer of the Erie R.R., has resigned to become President of the Seaboard Air Line Ry. Mr. Harahan was born at Nashville, Tenn., in 1867. He entered the railway service at 14 years of age as a messenger in the Superintendent's office of the Louisville & Nashville R.R., at New Orleans, La. The two years, 1884 to 1886, he spent as an apprentice in the shops and then served three years in the engineering and construction departments of this railway, until 1889, when he became Engineer of Maintenance-of-Way of the Cincinnati division of the Chesapeake & Ohio Ry. For the two succeeding years he was in charge of structures of the Baltimore & Ohio Southwestern Ry. In 1892, Mr. Harahan entered the operating department of the Illinois Central R.R. as Trainmaster of the Pontiac division. In 1895 he was promoted to be Assistant Superintendent of the Freeport division, and within the same year became Superintendent. From 1901 to 1902 he was Chief Engineer of the Illinois Central R.R., but he returned to the operating department to become Assistant General Manager, General Manager and finally Vice-President. A few years ago he went to the Erie R.R. as Assistant to the President and was elected Vice-President in charge of engineering and construction in January, 1911.

Mr. Gustav Lindenthal, M. Am. Soc. C. E., is Consulting and Chief Engineer and Architect of the New York Connecting R.R., which will connect the New York, New Haven & Hartford R.R. system with the Long Island R.R. and Pennsylvania R.R. systems by way of the great steel arch bridge over Hell Gate, East River, New York City. The other members of the engineering staff are Messrs. O. H. Ammann, Assoc. M. Am. Soc. C. E., of Philadelphia, Penn.,

Assistant Chief Engineer; H. W. Hudson, Assoc. M. Am. Soc. C. E., of Atlantic City, N. J., Engineer of Foundations and Masonry; F. E. Craft, Resident Engineer in the Bronx Borough; G. W. Philips, Resident Engineer on Long Island, and James P. Van Duyn, Resident Engineer of the East River section. Mr. Henry H. Hornbostel is Consulting Architect for the towers of the Hell Gate steel arch bridge, the plans for which have been approved by the Municipal Art Commission of New York City. The contracts for the foundations and masonry have been let to Arthur McMullen and the T. A. Gillespie Co. and Patrick Ryan, of New York City, and the contracts for the steel superstructure have been let to the American Bridge Co. and the McClintic-Marshall Construction Co. Each firm has about 40,000 tons of steel work to construct. The President of the New York Connecting R.R. is Mr. Samuel Rea, M. Am. Soc. C. E., First Vice-President of the Pennsylvania R.R.

Obituary

Lauraine L. Parke, a former Assistant City Engineer, of Salt Lake City, Utah, died in the mountains near that city, on Sept. 11, while on an inspection trip in connection with some mining property.

John LeRoy Brown, a civil engineer with the American Telephone & Telegraph Co., at Buffalo, N. Y., died Sept. 9, at his home in Springfield, Mass. He was a graduate of Worcester Polytechnic Institute, class of 1908.

Charles L. Harrison, M. Am. Soc. C. E., of New York City, died Sept. 15. Mr. Harrison graduated in civil engineering from the Missouri State University in 1880, and for several years was engaged in various engineering undertakings in the Middle West. In 1890 he was appointed Assistant Engineer on investigations for the Sanitary District of Chicago, Ill. For several years following he held responsible positions in the construction of the famous Drainage Canal, and in 1897 took charge of the surveys and examinations for the Niagara Ship Canal, under the supervision of the Corps of Engineers, U. S. A. On the completion of this work Mr. Harrison was Deputy Chief Engineer of the Board of Water Supply for the City of New York. His most recent work had been as Principal Assistant Engineer of the East River division of the Pennsylvania R.R. A more complete account of Mr. Harrison's work will appear in a later issue.

William Frederick Lockwood, whose death was noted in our issue of Aug. 29, was born in New York City, July 4, 1867. After leaving the public schools he learned the trade of steam fitter. He entered the engineering department of the Third Ave. Elevated Ry. during its construction in 1888 and upon the absorption of this company by the Manhattan Ry. Co. in 1891, Mr. Lockwood entered the Chief Engineer's office of the latter company as a draftsman. He was promoted to be Assistant Engineer and in 1900 became Road Engineer in charge of the maintenance of structures. During all this period Mr. Lockwood made up the deficiencies in his early education and, by night study at Cooper Institute, he received the degree of Bachelor of Science in 1894. In October, 1905, he was appointed Engineer of Maintenance-of-Way of both elevated and subway divisions of the Interborough Rapid Transit Co. During the 24 years in which he served the railways of New York City, these rapid transit highways have been tremendously developed and conditions of maintenance made very burdensome on account of deeper foundations of buildings and numerous subsurface street constructions. The adoption of electric motive power requiring the reinforcement of the elevated structures was in itself a great task.

His personality was fine. Of clear intellect, inflexible integrity, tireless industry, great patience and a charming presence, he was a power for influence and accomplishment.

Mrs. Lockwood and three children, Ruth, Blanche and Constance, besides three sisters survive him. [Abstract from the Bulletin of the Interborough Rapid Transit Co.]

Engineering Societies

COMING MEETINGS

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.
Sept. 23-28. Fifteenth congress at Washington, D. C. Secy., John S. Fulton, Senate Annex, Washington, D. C.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.
Sept. 25-28. Annual convention at Indianapolis, Ind. Secy., R. C. Harris, City Hall, Toronto, Ont.

NATIONAL IRRIGATION CONGRESS.
Sept. 30-Oct. 3. Annual meeting at Salt Lake City, Utah. Secy., Arthur Hooker, Salt Lake City.

COOPERATIVE SAFETY CONGRESS.
Sept. 30-Oct. 5. Annual convention at Milwaukee, Wis. Chairman, L. R. Palmer, 5852 Douglas Ave., East Pittsburgh, Penn.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.

NATIONAL CONSERVATION CONGRESS.
Oct. 1-4. Annual meeting at Indianapolis, Ind. Secy., Thos. R. Ship, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 7-11. Annual convention at Chicago, Ill. Secy., H. C. Donecker, 29 W. 39th St., N. Y. City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 8-11. Annual Convention at Quebec, Canada. Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Penn.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 15-17. Annual convention at Baltimore, Md. Secy., C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 21-25. Annual meeting at Chicago, Ill. Secy., T. A. Andreucetti, C. & N. W. Ry., Chicago, Ill.

AMERICAN ASSOCIATION FOR THE PREVENTION OF THE POLLUTION OF RIVERS AND WATERWAYS.
Oct. 23-24. Annual convention at Cleveland, Ohio. Secy., H. De B. Parsons, 22 William St., New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 29 So. La Salle St., Chicago, Ill.

American Society of Civil Engineers—At the meeting of the Colorado Association in Denver, on Sept. 14, discussion was opened on "The Cherry Creek Problem" by A. L. Fellows, City Engineer of Denver, Colo.

Engineers' Society of Pennsylvania—On Sept. 16, a lecture was delivered by Morris Knowles in the Society rooms at Harrisburg, Penn., on the subject of the "Conservation of Pennsylvania's Water Supply Resources."

Roadmasters and Maintenance of Way Association—At the annual meeting held at Buffalo, Sept. 10 to 13, officers were elected as follows: President, W. Shea, C. M. & St. P. Ry.; Vice-Presidents, T. F. Donahoe, B. & O. R.R., and W. R. Thompson, C. of Ga. R.R.; Secretary, L. C. Ryan, C. & N. W. Ry., Sterling, Ill. The next meeting will be held at Chicago in 1913.

Associated Engineering Societies of St. Louis—The first regular meeting of the Associated Engineering Societies, composed of the Engineers' Club and local branches of the A. S. C. E., A. S. M. E., A. I. E. E., and A. S. E. C., was held on Sept. 18, and an illustrated talk on the St. Louis Municipal Bridge was given by S. W. Bowen, who dealt particularly with the erection of the steel work.

Cleveland Engineering Society—The Cleveland Building Code was discussed at the first regular meeting of the year, Sept. 10, former Building Inspector V. G. Marani advocating that it be rewritten, simplified, and shortened, while present Building Inspector, V. D. Allen, held that the code needs only rearrangement. At a special meeting of the Society, held Sept. 24, a paper was read on "Apprenticeship Systems and Part Time Coöperative Schools in the United States," by J. F. Barker, Principal, East Technical High School, Cleveland, Ohio.

National Mine Rescue and First Aid Conference—Among the topics discussed at the conference, held at the Bureau of Mines experimental station, Pittsburgh, Penn., on Sept. 23-26, were the following: First-aid methods, training, contests and exhibitions; mine hospitals and management; breathing apparatus, safety lamps and appliances; training with breathing apparatus, and the conduct of rescue operations. An address was given by J. W. Paul on "Rescue and First Aid Work in the U. S. Bureau of Mines."

American Railway Bridge and Building Association.—The following are among the topics to be discussed at the 22d annual convention of the Association at Baltimore, Md., Oct. 15-17: Fireproofing timber trestles; concrete tank construction; the best and most economical pumping engines; reinforced-concrete culvert pipes; the development of turntables to meet operating conditions for the modern locomotive, showing the most improved practice; track scale construction and maintenance; and the painting of structural iron or steel for both bridges and buildings.